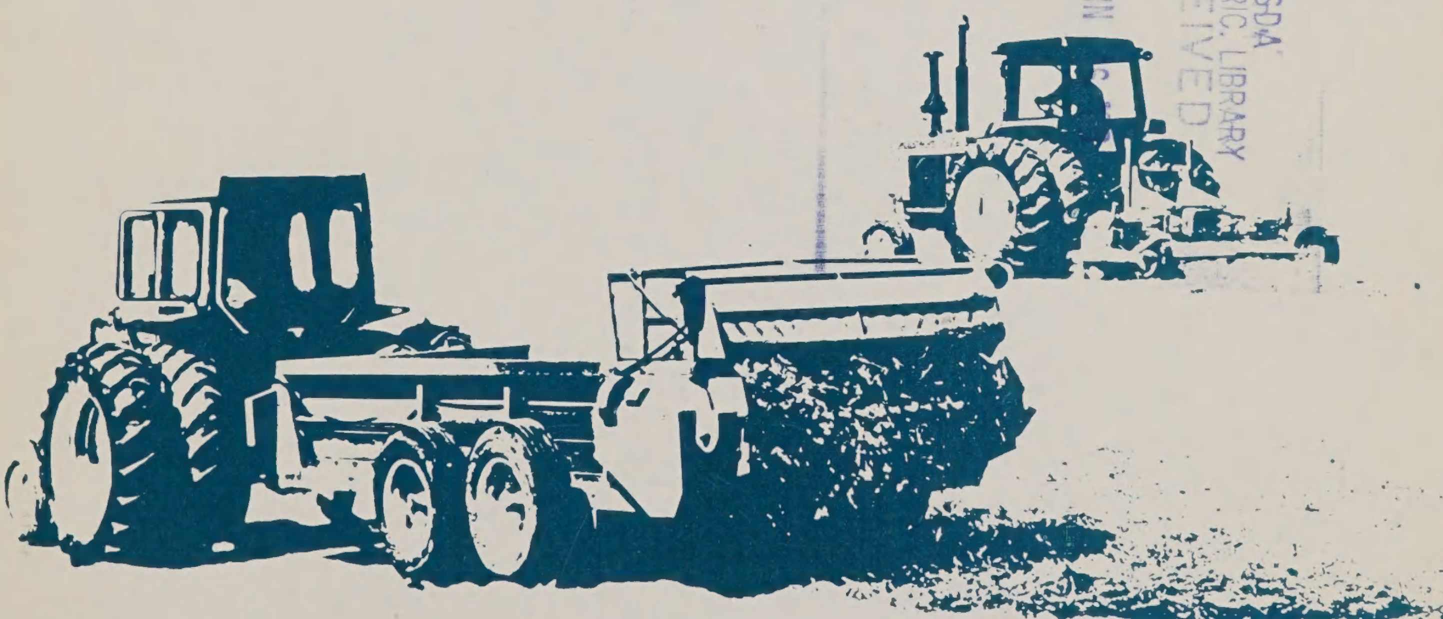
33rd Annual Report

Vegetative Rehabilitation & Equipment Workshop

Casper, Wyoming
February 11-12, 1979



The Vegetative Rehabilitation and Equipment Workshop is an organization of Federal and State agencies and private groups working to improve rangelands and further range equipment technology. Government officials and industry and university representatives from other countries also participate.

To accomplish its goals, the Workshop evaluates and develops equipment and prescribes specifications and standards for equipment purchase, maintenance, and use. The Workshop also functions as a clearinghouse for the interchange of information and the dissemination of material describing its activities and accomplishments.

Those interested in participating in the Workshop should contact its chairman, T. V. Russell, Range Management Staff, USDA Forest Service, P.O. Box 2417, Washington, D.C. 20013.

Cover: Rotavator (background) and mulcher spreader work in tandem to improve growing conditions on reclaimed mine site. The Forest Service Missoula Equipment Development Center modified the commercial mulch spreader for reclamation use.

July 1979

33rd Annual Report

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February 11-12, 1979

Participants

U.S. Department of Agriculture

U.S. Department of the Interior

State and County Organizations

State Wildlife Agencies

Industry Representatives (Chemical, Equipment, Mining, Seed)

Educational Institutions

Ranchers

Foreign Countries

7922 2805

In closing, I would be remiss if I didn't publicly acknowledge Don Seaman and Farnum Burbank for the excellent job of setting up the programs at Casper. Thanks a lot Don and Farnum!

San Diego is the site for our next annual workshop, February 10th and 11th at the Sheraton Harbor Island Hotel. Mark your calendar now and invite your friends to VREW in 1980.

Ted Russell

T. V. Russell, *Chairman*
Vegetative Rehabilitation
and Equipment Workshop

Agenda

Sunday — Feb. 11

9:00 a.m.	**Welcome**	Bill Evans
	Morning Discussion Leader	Ted Russell
	Introductory Remarks	Reg DeNio
	Workgroup Reports	
	Information	Ray Dalen
	Arid Land Seeding	Dan McKenzie
	Plant Materials	Gil Lovell
	Steep-Slope Stabilization	Lou Spink
	Disturbed Land Reclamation	
	Eastern "Sub" Group	Willis Vogel
	Western "Sub" Group	Don Calhoun
12:00 noon	**Lunch**	

1:00 p.m.	**Workgroup Reports**
	Seed Harvesting. . . . . Steve Monsen
	Seeding and Planting . . . . Dan McKenzie
	Thermal Plant Control . . . . Harold Edwards
	Mechanical Plant Control . . . . Dan McKenzie
	Chemical Plant Control. Ray Dalen
	Technical Standards . . . . Ted Russell
	Structural Range Improvements . . . . Ron Haag
	Afternoon Discussion Leader . . . . Art Armbrust
3:30 p.m.	**Papers**
	Towner Plowing Disk Harrow . . . . Wally Parmeter
	Spreaders and Associated Equipment for Reclaiming Surface Mines. . . . . Don Estes
	Reclamation: Innovations and Directions at the Rosebud Mine . . . . Chris Cull
	Affiliation with Other Land Reclamation Organizations. . . . . Farnum M. Burbank

Monday — Feb. 12

	Discussion Leader . . . . Wally Gallaher
8:00 a.m.	**Papers**
	Forest Service Equipment Development Center Activities. . . . . Jerry Edwards & Dick Hallman
	Public Law 95-87 and Reclamation Implications . . M. J. Cwik
	Native Plant Materials and A New Plant Center for Testing. . . . . Sam Stranathan
	Range Renovation Equipment for British Columbia Interior Grassland . . . . F. J. Feistmann
	Assessment of the Range Disk-Seeder-Packer Equipment in British Columbia . . . . A. H. Bawtree
	Automatic Transplanter Design Progress . . . . . . H. L. Brewer
	Water Harvesting Research Implementation . . . . . . Gary W. Frazier & Keith R. Cooley
	Grazing Reserve Development in Alberta . . . W. N. McLachlan
11:45 a.m.	**Wrap-Up** . . . . Farnum M. Burbank
12:00 noon	**Meeting Adjourned**

Contents

Introductory Remarks

Reginald M. DeNio, *Retired Director,*
Division of Range Management, Forest Service

I have been asked to comment, as I see it, on some of the past history as well as the current activities of the Vegetative Rehabilitation and Equipment Workshop. I am very pleased to have been offered this opportunity to make these remarks.

A few of us have had the opportunity of attending the sessions of this group from the beginning, both in participation and listening capacity. Other than the first session, I have attended all the sessions except the one at El Paso, Tex., in 1975. From 1960 until I retired in 1971 I had the responsibility of approving the final budget for the work program of this group. So I believe that I am fairly well qualified to comment on the past, and some of the present and future activities of this workshop.

From the earliest days of the U.S. Forest Service—the early 1900's—attempts were made by fieldmen to arrest and correct disturbed range areas. In the files of the Forest Service can be found a record of early attempts to seed disturbed areas of rangelands by primitive methods. One account I am familiar with describes a cooperative effort of the forest officer and of the sheep permittee placing the seed purchased by the Forest Service in the wool of the sheep and through this means distribution was made on disturbed areas. The success, as you might suspect, was negligible. However, the thought behind the action was important in recognizing the need to do something. After broadcasting seed by hand, covering by dragging limbs across the seed, etc., it was generally agreed that preparing a seed bed, and covering the seed was the best way to assure a successful stand of grass. This was done on sites favorable to use of the usual farm machinery available. But it wasn't true of sites that were rocky, steep, and generally unfavorable to the use of available commercial equipment. It didn't take too long to run out of good sites, and the difficult ones needed attention. Equipment needed to be designed for use in seeding the difficult sites.

Last year at San Antonio, W. R. Chapline told you what events led to the conference in 1945 of the Forest Service Western Regions and Experiment Stations, which were concerned with rangeland seeding. At this meeting the bottom line was the need for suitable equipment. To obtain such equipment, the Range Seeding Equipment Committee was formed. The skills available at the Equipment Development Center—later at Arcadia and now at San Dimas and Missoula—were and are essential to the success of testing, adapting, and designing equipment to do the necessary vegetative rehabilitation

work. The committee was not large, most informal, and consisted exclusively of Forest Service personnel. I still have the letter I received through the Regional Forester from the Chief of the Forest Service designating me the official representative of Region One on the committee.

A number of individuals who were responsible for the rangeland seeding research work at the Forest Service Experiment Stations were to be transferred along with Research to the Agricultural Research Service of the U.S. Department of Agriculture. This caused concern to the committee and a flurry of letter writing to Congressional delegations to stay the action. However, the work was transferred and the ARS or Science and Education Administration as it is now named, has continued to be a contributing agency to the workshop.

Attendance at the Range Reseeding Committee annual meeting was not large—about 25 individuals during the early years. However, the enthusiasm with which committee members handled their assignments attracted others working on public lands. As a group we Forest Service personnel were rather clannish, and it wasn't without a considerable amount of controversial discussion that the Bureau of Land Management and Soil Conservation Service folks were invited to attend the committee meeting in 1949. The meeting at Denver in 1949 was not harmonious and much haggling occurred, even over the name of the committee (Seeding or Reseeding) and the expansion of the purpose of the committee. No doubt the charter of the Range Seeding Committee was better understood when the debate was over. In 1951, at our meeting in Billings, Mont., the BLM participated in financing some of the program. The Bureau of Indian Affairs' financial participation began in 1955 and has continued since then. SCS made its first financial contribution in 1956.

Most of the engineering and equipment development work has been done by Forest Service Equipment Development Centers with financial support by BLM, BIA, and Forest Service. These agencies and others contribute much time and equipment in field testing and evaluation.

In 1974 the name "Vegetative Rehabilitation and Equipment Workshop" was adopted. It has been an informal organization with no restrictions on membership or participation. The workshop has broad aims, defined as follows:

- Keep abreast of commercially developed equipment and make modifications as required for wildland use.
- Develop equipment, if not commercially available, with priority dependent upon urgency of needs.

These briefs of the past history and evaluation of this workshop are meant to indicate that the survival of this effort was not a sure thing. At times it was doubtful it would survive—particularly financially. If some of the other agencies had not joined the Forest Service with financing, the effort would have been in difficulty.

The most important competence available from the Forest Service was the engineering know-how at the Equipment Development Centers. There always was a question of being able to finance project proposals at the Equipment Development Centers, hence the priorities. Much competition existed for the top priorities in the work plan when planning and budgeting. However, during those years we were most informal, and we were only concerned with the rangelands in the western ecosystems. Later on we became concerned with wildlife proposals and more recently proposals related to vegetative rehabilitation on disturbed areas because of mining, etc., both in the western as well as eastern ecosystems.

The efforts of many people have gone into making this workshop a success. However, it wasn't until 1960 that the Division of Range Management, Washington Office, with the additional staffing provided the continuity needed to insure a successful program. This staffing continues and with the new more formal "project proposal processing" I am sure the workshop will be even more successful.

In 1978 at San Antonio, we participated in a very sophisticated workshop—compared to earlier years—on vegetative rehabilitation and equipment. It was without doubt well organized and attended. The large attendance enhanced the workshop. The 135 registrants represented 9 Federal agencies, 10 universities, 4 wildlife organizations, 2 foreign governments, a number of retirees and individuals, and 30 registrants representing 25 different industries. It was quite gratifying to see that about 22 percent of the registrants were from private industry. It is interesting to me because in earlier sessions private industry really was not encouraged to attend. I guess we were fearful of being obligated. The private industry participation provides the opportunity for interchange of information that is necessary for a successful workshop.

As a long-time attendee of this workshop, I hope that I have made it abundantly clear that I believe that much progress has been made in the development of vegetation rehabilitation equipment. However, the main thrust seems to be in the development of equipment proposed for areas of land disturbed for reasons other than livestock grazing. I think it is a timely endeavor for this workshop to interest itself in projects other than for rangeland improvements. In doing so I am sure the means to finance the proposed projects are most important.

It seems to me that projects essential to rangeland improvement in recent years are at a minimum in the program. I don't agree that the proposed projects for disturbed areas should be lessened, but I think the rangeland improvement projects should be increased. I would think it important that considerable thought should be given to increased proposals for range improvement when some 170 million acres of land in 11 States are administered by the Bureau of Land Management and the Forest Service. A Bureau study determined that 80 percent of acreage is in fair, poor, or bad condition—and we are talking about livestock rangelands. The condition of the rangeland indicates a need for revegetation. Do we already have the necessary equipment to treat so much low producing rangeland? I don't think so.

In reviewing the programs for FY 78 and 79, both are essentially lacking in what would be considered range projects. In FY 78, under Equipment Development and Test (ED&T) Project 2624, Ray Dalen's thrust continues to concentrate on spray drop spectrum, meteorology, and the like. Apparently he wasn't too impressed with Norman B. Akesson's handbook draft. However, the handbook could be of value to Range if reoriented, as indicated will be done. ED&T 2627: While perhaps of some value to Range, most sage burning projects are not of sufficient size to justify the expense of a chopper or plane. ED&T 8022: Apparently updating the handbook? ED&T 2532: Has questionable value to livestock range. Appears to be mainly wildlife oriented.

In FY 79 ED&T 8022 and 2532 indicate $21,100 out of $387,000 for rangeland improvement projects. In FY 78 and 79 $25,500 would be spent in 2 years for updating handbook (if that is what is being done?). It wouldn't seem the $56,000 is going for essential range-oriented projects.

It may be that too good a job has been done in past years. But it also might mean that innovativeness is lacking on the part of the rangeland-oriented members of this workshop. Lack of rangeland projects may also mean lack of financial means to do the necessary equipment development for better range improvements. The recently enacted Public Rangelands Improvement Act, authorizing $360 million for improvement of Federal rangelands should eventually mean more financial aid for range improvement projects. To do the necessary job on the "54 percent of the rangelands in the 'lower 48' States— some 350 million acres of private, State, and Federal rangelands—in poor or in very poor condition, with vegetation and soil conditions estimated to be at or less than 40 percent

of their potential,"[1] workshop members will not only need to be innovative, but all will need real money—not $56,000.

I am aware of Kent A. Crofts statement in his paper, at the 32nd meeting in 1978 of this workshop, titled "Coal Mine Reclamation in Colorado." I am not advocating any decrease in the current research effort in the field of equipment development adapted to handle the particular problems of strip mined land reclamation. I am advocating that rangeland improvements need more interest than I think this workshop is giving to rangeland oriented improvement equipment projects. I also couldn't agree more with the statements made by Don Mellgren in his presentation at the 32nd meeting of the workshop in 1978, titled "Disturbed Land Reclamation and Environmental Problems on Eastern Ecosystems." In his introduction he states: "I personally don't think it makes any difference whether surface disturbance is the result of overgrazing, fire, mining, or other causes. Each contributes adverse impacts upon the environment which should be corrected effectively, efficiently, and economically."

Thank you.

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[1] Remarks of Dr. M. Rupert Cutler, Assistant Secretary of Agriculture for Conservation, Research, and Education at the symposium on "Rangelands Policies for the Future," Tucson, Ariz., Jan. 19, 1979 (p. 5).

Workgroup Reports

Information

Ray Dalen, *Chairman*

Information Workgroup Support (ED&T 7083)

Effective dissemination of information is a challenge that any group or organization engaged in development work faces. Information transfer, however, is an activity often put aside because the work is routine and not appealing to most people engaged in development work. But in the long run, publishing or otherwise making known what has already been developed should be the first goal of a group engaged in furthering technology. This is especially true in resource management, where field units are widely scattered and personnel usually work independently. It is difficult for many land managers to stay abreast of the best tools and techniques available.

The Information Workgroup was begun in 1975 to disseminate information concerning Workshop goals and accomplishments, including technical reports, visual aids, and general material. A mailing list was compiled of Federal and State agencies, national organizations, universities, private industry, and individuals interested in Workshop activities and projects. Work for the coming years will be determined by the members of the Information Workgroup. As in past years, the annual report will be prepared and distributed under workgroup auspices by the Forest Service Missoula Equipment Development Center.

Range Equipment Handbook (ED&T 8022)

The *Range Seeding Handbook* was probably one of the best products of the old Range Seeding Equipment Committee during its 25-year existence. Last printed in 1965, the handbook served as a bible for many working in range habitat improvement. Although the book is out of print, the Forest Service Equipment Development Centers at Missoula and San Dimas still get requests for it. Unfortunately, no publication has come along to take its place. Because the Workshop is looked to for leadership in rangeland equipment, a project was begun to update the handbook.

Work began in 1978 with the preparation of an outline for the revised handbook. Information was then gathered from equipment manufacturers and others. Draft copies are being reviewed by workgroup chairmen. Final comments will be incorporated and the handbook published and distributed in 1979.

Arid Land Seeding

Carlton H. Herbel, *Chairman*

(Reported by Dan W. McKenzie)

During the past year an area on the Jornada Experimental Range infested with creosotebush and some honey mesquite was rootplowed and seeded with the arid land seeder prototype equipment developed in the 1960's. Lehmann and Boer lovegrass, black and sideoats grama, yellow-bluestem, blue panicgrass, and fourwing saltbush were used in the seeding. The Jornada Experimental Range is planning to treat about 200 acres with this equipment so the effects of rootplowing and seeding on the ecosystem can be studied.

Other vegetative rehabilitation equipment that members of the workgroup are developing are, a low-energy grubber, new rangeland seeder, disk-chain, and land imprinter. They are reported below.

Low-Energy Grubber, Experimental Disk-Chain, and New Rangeland Seeder

By Harold T. Wiedemann, Texas A&M University
(Presented by Bobby T. Cross, Texas A&M University)

Low-Energy Grubber

A low-energy grubber developed by the Texas Agricultural Experiment Station, Vernon, Tex., has proven to be economical and effective in controlling small trees and brush. The unit is best suited for grubbing trees and brush 1-foot to 8-feet tall in densities of 35 to 200 plants per acre. This grubber has proven effective in mesquite, juniper, algerita, huisache, and blackbrush reinfestations on previously cleared pastures. Grubbing rates of 2 to 10 acres per hour have been achieved at costs of $2.50 to $12.50 per acre on a contract basis. A special U-shaped blade severs the roots 6 to 12 inches below ground to prevent sprouting. The development of a unique hydraulic attachment has increased tree-cutting capacity by one-third and has resulted in effectively uprooting trees that are from 4 to 22 inches in diameter. This low-energy grubber is described by H. T. Wiedemann, et al., 1977, "Low-Energy Grubber for Controlling Brush," *Transactions of the ASAE* 20(2): 210-213.

Low-energy grubber with hydraulic attachment to adjust cutting blade angle for improved soil penetration and stump splitting.

New Rangeland Seeder

An experimental rangeland seeder developed by the Texas Agricultural Experiment Station features a promising new concept for metering fluffy grass seed and a new method of seed placement in rough, log-littered, rootplowed rangeland. Uniform seed metering is accomplished with a semicircular seedbox, auger agitator, and pickerwheel. A double-run, internal cup feed mechanism meters small slick grass seed. The flexing runner openers can cross 12-inch logs without breakage. Comparative results over a 5-year period from nine ranch locations include aerial and drill seeding, seedbeds prepared by chaining, roller chopping and disking are covered by H. T. Wiedemann, et al., 1979, "Seed Metering and Placement Devices for Rangeland Seeder," *Transactions of the ASAE*, in press. Several manufacturers have expressed interest in commercial production of the seeder.

Experimental rangeland seeder near Guthrie, Tex.

Experimental Disk-Chain

A disk-chain, currently under study by the Texas Agricultural Experiment Station, holds promise in reducing cost and energy requirements of seedbed preparation by one-half to two-thirds on rough, log-littered, rootplowed rangeland. Disked seedbeds have consistently given better results than seedbeds prepared by smooth chaining in studies over a 5-year period; however, chaining is substantially lower in cost per acre than disking. Combining the best of both systems has resulted in the development of a disk-chain. Field results show grass densities of 0.41 and 0.13 plants per square foot for disk-chaining and smooth chaining respectively, using 1 pound PLS (pure live seed) per acre of Kleingrass aerially seeded in tests conducted in 1978. Disk-chaining appears very promising because it is well adapted to treatment of extensive acreages, disturbs the soil well, reduces costs by one-half to two-thirds, and generally does not require costly raking.

Disk-chain in operation on rangeland.

Land Imprinter

By Robert M. Dixon, Science and Education Administration
(Presented by Gary Frasier, Science and Education Administration)

The Science and Education Administration began development of a rangeland imprint seeder in 1976. This seeder is designed to produce a seedbed microclimate suitable for seed germination and subsequent seedling establishment. Specifically, it is designed to:

1. Form mulch-lined rainwater-irrigated seedbeds without inversion of the soil surface.

2. Convert above-ground plant materials into an effective surface mulch.

3. Operate satisfactorily without breakdown and rapid wear on rough, rocky, and brush-covered terrain.

4. Protect and conserve existing soil, water, and vegetation regardless of post-treatment climatic conditions.

5. Interrupt well-drained microtopography (network of interconnected rills and small gullies) by impressing the soil surface with complex patterns of closed (and crisscrossing) vee furrows.

6. Convert concentrated storm runoff to diffuse runoff for controlling erosion.

7. Increase depression storage of rainwater up to 2 inches by forming closed-geometry microroughness.

8. Kill shrubs while only slightly thinning native grasses.

9. Increase populations of macropore-forming soil invertebrae.

10. Operate satisfactorily on any slope considered safe for prime mover and operator.

11. Firm the soil surface slightly to enhance moisture flow to seeds and decrease soil detachability under rain-drop impact and overland flow.

12. Operate satisfactorily at speeds up to 6 mph.

13. Yield a favorable benefit-cost ratio through low cost of treatment and marked increase in forage production.

Rangeland imprint seeder.

Preliminary tests, involving the imprint seeding of more than 2,000 acres, indicate that the preceding 13 design objectives are being adequately met.

A commerical broadcast seeder (12-volt dc) was mounted directly behind one of the imprint capsules to scatter about half of the seed over the newly imprinted surface and the other half on adjacent unimprinted land to be pushed into the soil surface on later passes of the imprint seeder.

Future development plans include: (1) further testing of the imprint seeder's ability to satisfy its design criteria and, (2) further refinement and adaptation of the imprint seeder for a wide range of specific uses.

Plant Materials

Gil Lovell, *Chairman*

The Plant Materials Workgroup has been active compiling, and updating previous reports on new or improved plant materials. The workgroup's prime goal for 1978, completing and publishing an updated listing of released plant materials suitable for rangeland rehabilitation, has been achieved. The results are presented in this table:

Table 1.—*Plant varieties released in 1978 suitable for range and stabilization*

Species	Variety	Common name	Test number	Released by	Area of use
Cenchrus ciliaris	Llano	Buffelgrass	Ex. Hy. 331	SEA; TX AES; SCS	From Llano River South in TX
Cenchrus ciliaris	Neuces	Buffelgrass	Ex. Hy. 2-1	TX AES; SCS; SEA	From Neuces River South in TX
Cercocarpus montanus	Montane	Mountainmahogany	NM-715	SCS; NM AES; CO AES	CO and NM between 3,500 and 9,500 feet elevation
Chilopsis linearis	Barranco	Desertwillow	NM-778	SCS; NM AES	West TX to southern CA, South of Albuquerque, NM
Elaeagnus angustifolia var. orientalis	King-Red	Russian-olive	WY-292A	SCS; NM AES; CO AES	Full range unknown - much of NM and CO, 3,500-7,000 feet elevation
Foresteria neomexicana	Jemex	New Mexico foresteria	A-12044	SCS; NM AES; CO AES	Considerable drought tolerance at elevations of 3,000-7,000 feet over much of CO and NM
Helianthus maximiliani	Aztec	Maximilian sunflower	PMT-1564	SCS; TX AES	Areas of TX and OK receiving 18 inches or more ppt.
Helianthus maximiliani	Prairie Gold	Maximilian sunflower	PMK-1425	SCS; NE AES	KS, NE, northern OK, and eastern CO
Oryzopsis hymenoides	Nezpar	Indian ricegrass	P-2575	SCS; ID AES	Full range unknown - ID on range and surface mined areas
Panicum virgatum	Alamo	Switchgrass	PMT-788	SCS; TX AES	Better adapted to southern half of TX than other cultivars
Phragmites australis	Shoreline	Common reed	PMT-2376	SCS; TX AES	Full range unknown— TX, OK, and KS
Ratibida pinnata	Sunglow	Grayhead Prairieconeflower	PMK-1158	SCS; NE AES	Plant communities of the true prairies; KS, NE, IA, MO
Yucca elata	Bonita	Soaptree yucca	NM-748	SCS; NM AES	Southwest TX, central AZ and NM at elevations of 1,500-6,000 feet

Steep-Slope Stabilization

Lou Spink, *Chairman*

Steep-Slope Seeder

After planting tests on the Boise National Forest proved that the steep-slope seeder was successful, several improvements were made to it. This improved San Dimas Equipment Development Center seeder was then evaluated on the Willamette National Forest in April 1978. The reasons for the Willamette trials were to evaluate the seeder's mechanical reliability and ascertain production rate and operating costs.

In 5 days, approximately 25 acres (10 ha) of roadside slopes were planted; additional time was spent in training two operators and in seeding a recreation site. The seeder/crane combination showed it was capable of seeding up to 2 acres per hour (0.8 ha/hr) when travel time between sites was short, etc.

Steep-slope seeder.

Grass planted by the seeder.

The cost of operating the seeder/crane combination was $59 per acre. This includes hourly boom crane (Gradall) use rate, two wage-grade equipment operators, a swamper, and a pickup truck. The total cost per acre was about $100, which includes 40 pounds (15 kg) of seed and 160 pounds (60 kg) of fertilizer. This cost is much cheaper compared with typical costs for the Forest Service Pacific Northwest Region:

Seeding Method	Cost/acre
Hydroseed	$400 to $600[1]
Broadcast	40[1]
Broadcast with straw mulch and net	3200[1]
Steep-slope seeder	100[2]

1 Average for Pacific Northwest Region.

2 Actual test data collected during Willamette test.

Overall the seeder was operated on both cut banks and fill slopes. Most fill slopes were mild, but some were as steep as 1½:1. However, cut banks ran as steep as ¾:1. Both cuts and fills were littered with rock, stumps, limbs, etc. The seeder performed reliably, adapting well to terrain and performing well in spite of the litter.

The steep-slope seeder is not considered finalized. Formal drawings for seeder fabrication are available from the San Dimas Equipment Development Center.

Tree/Shrub Planter

Development of a tree/shrub planter for the steep slopes along roadsides is a little behind the seeder because the seeder was judged to be the higher priority. The tree/shrub planter is, however, expected to be completed in FY 1979. At present, we have a prototype that has been successfully tested at San Dimas. It has planted several varieties of shrubs and has been used on slopes up to about 60 percent without any problems.

The planter is designed to operate on slopes up to 1:1. It can be carried and positioned by many varieties of cable cranes, some of which can reach out over 100 feet (30 m) from the road with the weight of the planter. It is designed to plant stock that was grown in containers up to 8 inches (20 cm) long. The planting cycle, once initiated by the crane operator, is fully automatic and the time required to plant a shrub is about 12 seconds.

Tree planter being positioned by crane.

Detail view of tree planter.

The tree/shrub planter digs a hole with an auger, minimizing soil compaction around the root system. It uses a short, high-velocity blast of water to propel the seedlings down the drop tube and into the hole. A hydraulic cylinder then compacts soil around the seedling while creating a small depression that should prove valuable to catch water. The containers recommended are easily removed before loading the seedlings into the planter.

Field testing to check plant survival, machine reliability, production rate, and planting costs are scheduled for March or April 1979 in the Pacific Northwest Region.

Disturbed Land Reclamation (Eastern "Sub" Group)

Willis Vogel, *Co-Chairman*

In revegetating areas disturbed by surface and underground mining, several kinds of equipment are used for seedbed preparation, seeding, lime and fertilizer application, lime incorporation, and mulching. Most is standard equipment normally used for these purposes, but some of the equipment has been specially developed or modified. In a separate presentation, Don Estes of Estes Equipment Co., Winchester, Ky., will discuss principles, procedures, and equipment he uses to revegetate surface mines and coal refuse (gob) piles in the Appalachian coal region.

Several reclamation problems on eastern surface mines require special attention. One is the revegetation of steep slopes of extremely acid spoils, especially on contour surface mines. To support vegetation, these acid spoils must be limed, often with very heavy rates. Application of lime and other amendments usually can be accomplished with little difficulty. But, on the steep slopes, there is no way to incorporate the lime into the soil. Incorporation of lime is absolutely essential for establishment and growth of vegetation. This requires more than superficial scarification. Equipment developed especially for this problem would usually be operated from the bench above the slope. Perhaps suitable equipment cannot be developed and the only solution is to reduce the steepness of the slope with dozers to a slope angle that can be traversed on the contour with farm equipment.

Another concern is with the disposal of the woody vegetation cleared ahead of the surface mining operation. Federal regulations imposed by the Surface Mining Control and Reclamation Act of 1977 will probably restrict the methods for disposing of this woody vegetation. Burning will probably be in violation of air pollution laws.

One alternative is to chip the woody vegetation and use the chips for mulch when reclaiming the disturbed site. Wood chips are also useful in controlling dust on haul roads. In some areas, selling whole tree chips to pulp and paper mills may prove economically feasible for the mining company. At present, some research is underway by the Forest Service Northeastern Forest Experiment Station at Berea, Ky., to determine the ecologic and economic feasibility of using chips for these various purposes.

If chips are deemed feasible for these purposes, there may be a need to develop special equipment or test existing equipment to more efficiently cut, handle, and chip the woody vegetation. With present methods, the trees are cut and dragged to a portable chipper. This procedure is obviously more difficult on steep slopes than on gently sloping land.

Revegetation problems also occur where intensive earthmoving and grading is done for the purpose of returning surface mines on steep slopes to the original slope angle. Not only is the erosion hazard increased on these newly formed back-to-contour slopes, but the intensive traffic of grading equipment also badly compacts mine soils, especially in the rooting zone of plants. The compaction problem is further compounded where clayey subsoils must be spread on the surface to meet topsoiling requirements. Before plants can successfully take root, ripping is required to break up the artificial hardpans created by grading. Terracing may be necessary to alleviate erosion on the long slopes.

Future work to overcome and resolve these and other reclamation problems will probably be initiated and accomplished largely by the surface mining and equipment industries with some direction and cooperation from government regulatory and research agencies. Some members of this workgroup are in positions to conduct research and advise on these and related problems. Use of some of the reclamation equipment being developed in the West may have application to some of the eastern problems.

Disturbed Land Reclamation (Western "Sub" Group)

Don Calhoun, *Co-Chairman*

My report for 1978 is going to be quite brief. There have been some significant achievements during the year that relate to this committee's work, and these will be described by Dick Hallman. I want to devote the remainder of my time to Dr. Thomas Davidson, who will describe the program entitled the Ecosystematic File of World Crops. This program is important to everyone in the world dealing with land reclamation or rehabilitation.

I also hope that during the equipment session we will be able to hear from Herb Runkle, who is the head of the BLM EMRIA (Bureau of Land Management Energy Mineral Rehabilitation Inventory and Analysis) staff. This group has supplied a large part of the funding in recent years for the VREW program, and it is my hope that this will continue for another year or two at least. I hope that Herb will see what has been accomplished and also what the needs are, and agree with this position.

Equipment Development Projects for Disturbed Land Reclamation

By Dick Hallman, Forest Service

In 1978 work was completed on three projects at the Forest Service Missoula Equipment Development Center (MEDC) that were funded by the Bureau of Land Management under its EMRIA (Energy Mineral Rehabilitation Inventory and Analysis) Program. These projects were ED&T 2629, Soil Conditioner for Disturbed Land Revegetation; ED&T 2630, Transplanter for Disturbed Land Revegetation; and ED&T 2631, Gouger for Disturbed Land Revegetation. Reports and drawings for these projects are available from the Center.

The Center is currently funded by the BLM for four additional projects related to disturbed land revegetation. The following brief outline of each project describes the problem to be solved, the project goal, prior work done, if any, and project objectives.

ED&T 8041—Basin Blade

Problem. On the semiarid ranges of the Western United States, various methods are being used to make depressions in the soil to trap moisture and to create a more favorable microclimate for vegetation. Depending on the specific needs, depression size can vary from small pits to large dozer blade scalps. On slopes up to 10 percent, where depression sizes can be fairly small and shallow and still work effectively, many kinds of equipment are available. But on slopes above 10 percent, equipment options are restricted. Dozer blades and plows are most common. There is a need to develop equipment specifically designed to build larger depressions-basins on slopes above 10 percent.

Project Goal. The goal is to make available to personnel working in land rehabilitation, a basin-building machine to help stabilize and revegetate steeper slopes.

Prior Development. Richard Hodder, agricultural

Basin blade.

extension agent, Montana State University, has developed a prototype basin blade that is towed by a D-8 or D-9 size crawler tractor. The Hodder basin blade is capable of creating "bathtub" size depressions on slopes up to about 45 percent. The basin blade is raised and lowered by the operator, who can vary basin length, width, and depth. However, the prototype model cannot be tilted to permit the operator to build basins in either direction as he contours the slope. He must "deadhead" one way, which requires twice as much time to cover an area. The results of several years of testing the basin blade indicate that it is an effective rehabilitation tool, but design changes must be made to improve the unit's production rate.

Project Objectives. In FY 1978 we tested the Hodder basin blade to determine what design changes were needed, then designed and built an improved blade that can build basins in either direction as the operator contours a slope. The blade performed successfully in field tests in FY 1979. In addition, attachments have been designed so that the basin blade can be pulled by a variety of crawler tractor makes. Our work will be documented in a report and final drawings prepared to complete the project.

ED&T 8042—Dryland Plug Planter

Problem. Planting of trees and shrubs on reclaimed strip mined lands in the Western United States has generally not been successful. In the process of lifting bare root stock from the nurserybed, most of the fiberous roots are destroyed. This greatly reduces the plant's ability to take up moisture and nutrients from the soil after planting. On forested sites where bare root stock is commonly planted, enough soil moisture is usually available to get the seedlings through the first growing season. On reclaimed mined sites in semiarid locations this is not the case. Techniques such as container planting must be used to improve survival. The problem is that hand planting of large containerized stock (18- to 24-inch-high containers) is difficult and slow. A mechanized system is needed to plant reclaimed sites with large containerized stock.

Project Goal. The goal is to make available a dryland plug planter that can be used to successfully establish containerized trees and shrubs on reclaimed sites subjected to harsh growing conditions.

Prior Development. Personnel engaged in mine land revegetation are beginning to experiment with plug planting in the Western United States. Early results indicate that containerized stock, properly used, can speed up revegetation and reduce costs because of better survival. To date, however, all plug planting on reclaimed land has been done by hand. A number of automated plug planters are currently being developed for forest planting, but these machines are all designed for small plugs (2 to 8 cubic inches). In FY 1978 MEDC began this project by meeting with experts to determine the criteria for a dryland plug planter. With that established, the design of a prototype model was begun and essentially completed before the end of the fiscal year. During FY 1979 the prototype machine is being fabricated and will be field tested and redesigned as needed.

Project Objectives. In FY 1980, a second prototype planter will be built, field tested, and modified as needed. Also planned are final construction drawings, specifications, project report, and a slide/tape operator instruction series. Project work and documentation will be completed in FY 1981.

ED&T 8046—Dryland Sodder

Problem. One of the greatest concerns land managers have regarding reclamation of strip mined areas is replacement of topsoil on reshaped spoil material. No method has been found that will allow the topsoil to retain its structure if it is moved. Topsoil has very definite gradients of organic matter, nutrients, microorganisms, and toxic materials. All the methods now used to segregate topsoil from subsoil destroy these gradients. Preserving the topsoil with its structure intact would be a tremendous advance in reclaiming strip mined lands.

Project Goal. The goal is to make available to land managers a method of moving topsoil while preserving its structure.

Prior Development. In FY 1978 Center engineers conducted a market and literature search to determine what commercial equipment was available to modify and use as a dryland sodder. From this information several concept designs were made and evaluated by the sponsor. A modified front-end loader bucket was selected as the first prototype dryland sodder. In FY 1979 a dryland sodder was designed and is scheduled to be built and tested before the end of the fiscal year.

Project Objectives. In FY 1980 we plan to design, build, and test a second prototype dryland sodder. Testing and modification of the machine will be accomplished in FY 1981. In FY 1982 testing will be completed and final drawings, specifications, and reports prepared.

ED&T 9120—Sprigger for Native Shrubs

Problem. Most Western States have stipulations in their mined land rehabilitation laws that require revegetating disturbed surface lands with native vegetation. This is most easily done by sowing the seeds of native plants. However, because of the harsh sites and the frequent drought conditions found in the western coal areas, this technique often results in failure. It is now possible to buy containerized native plant material from commercial growers, but the cost can be too high for large-scale planting. In most cases native plant material is already growing on the site or nearby. This is an ideal source of planting stock because its suita-

bility for surviving in the area has been proven. The problem is to transplant successfully the material from where it is found to where it is needed.

Project Goal. The goal is to make available equipment and techniques to allow the efficient movement of native plants for disturbed land revegetation.

Prior Development. Dick Hodder has conducted experiments to test the feasibility of extracting large numbers of stems or sprigs from rhizomatous plants for mine land revegetation. The sprigs are simply spread out on the area to be revegetated and covered with soil. The tests indicate that this method can be used successfully if equipment is developed to make the process efficient. MEDC began working on this project in FY 1979. The criteria for the sprigger were established and a market search was conducted to determine what commercial equipment is available to modify for this use.

Project Objectives. In FY 1979 we purchased a potato windrower and tested it as a sprig lifter. Based on test results, we are modifying the machine and will field test it again in FY 1980. A market search will be made to purchase equipment that can be modified to use as a sprig transport and planter. The equipment will be tested, modified, and retested. A progress report will be written to describe all the work done to date. In FY 1981 final testing will be done, and drawings, specifications, and a report are planned. Project work and documentation will be completed in FY 1982.

Dryland sodder.

Computerized Vegetational Data to Assist in Disturbed Land Reclamation

By Thomas Davidson, Science and Education Administration, and Richard Hodder, Montana Agricultural Experiment Station

Abstract—The Ecosystematic File of World Crops maintained by Dr. James A. Duke of the U.S. Department of Agriculture's Beltsville (Md.) Agricultural Research Center is a computerized data base of plants important for food, forage, fiber, and oil in the world economy as well as weed species and, to a more limited extent, indigenous species that are neither crops nor weeds. Each record in the file contains the plant name, the location where grown, and the ecological data describing the edaphic, climatic, and biotic parameters of the plant's environment.

An effort is being made to include plant species in the ecosystematic file that are useful in disturbed land reclamation. This effort is being made under the direction of the second author through a project, "Computerization of Semiarid Mineland Plant Species," with support arranged through Dr. Eilif Miller of Cooperative Research.

A questionnaire has been developed to assist in the collection of pertinent ecological data relative to mineland plant species. Once these data have been entered into the ecosystematic file, it will be possible to query the system on the basis of a sufficiently complete list of plants known to succeed in the area to be reclaimed. Alternatively, the data base can be queried by supplying a listing of the annual temperature and precipitation along with other pertinent ecological factors. In either case the system will provide a listing of plants that are known to succeed in similar ecological situations and could be expected to grow effectively under the particular conditions indicated.

The effectiveness of this cooperative project in attacking reclamation revegetation problems initially depends on reliable input into the system via the Reclamation Vegetational Ecosystematic Questionnaires, and ultimately on the frequent use and application of data available from the ecosystematic files.

Questionnaire packets may be obtained from Richard Hodder, Reclamation Research, Montana Agricultural Experiment Station, Bozeman, Mont. 59717.

Seed Harvesting

A. Perry Plummer, *Chairman*

(Reported by Stephen Monsen)

Lightweight Seed Collector (ED&T 2623)

Two backpack seed collectors designed and fabricated under contract have undergone field testing. These tests showed a backpack seed collector is feasible; however, the marginal performance of these units does not merit fabrication of additional units for field use. The workgroup suggested that the Forest Service San Dimas Equipment Development Center (SDEDC) consider alternatives and new concepts for a backpack or lightweight seed collector with heavy emphasis on an affordable unit. With this new direction the SDEDC designed and produced an air amplifier unit powered by compressed air and furnished two for field testing at Ephraim, Utah, and Boise, Idaho. Also, SDEDC is investigating other alternatives and concepts. The following are two field reports on the air amplifier units and a report by San Dimas on new concepts being considered.

Air Amplifier Seed Collector

By Kent R. Jorgensen, Utah Division of Wildlife Resources
(Presented by Richard Stevens, Utah Division of Wildlife Resources)

Federal funds were provided for this work through Project W-82-R, aid in Wildlife Restoration.

The air amplifier seed collector was designed by the Forest Service San Dimas Equipment Development Center. The machine is run by a standard air compressor with 65 to 90 pounds per square inch pressure and requires 40 cubic feet of air per minute.

The backpack, sacker, flexible hose, and nozzle weighs 19 pounds. The inside dimension of the nozzle is 3 inches.

The design of this machine is a great improvement over the backpack seed collector (ED&T 2623). The air amplifier collector is 25 pounds lighter than the backpack collector. This reduces both weight and bulk of the collector. Troubles encountered with the backpack, such as hot spots on the engine and noise, have been reduced or eliminated. Protective ear devices are not needed with the air amplifier collector.

This machine was tested in central Utah on several species, however, the wet fall and early winter did not permit the extensive testing required to make a fair evaluation on many of the fall maturing species.

Species tested that showed good results were those having plumed seed, mainly Pacific aster (*Aster chilensis adscendens*), blueleaf aster (*Aster glaucodes*), goatsbeard, (*Tragopogon porrifolius*), virginsbower (*Clematis ligusticifolia*), low rabbitbrush (*Chrysothamnus viscidiflorus*), and big rabbitbrush (*Chrysothamnus nauseosus*). In tests on true mountain mahogany (*Cercocarpus montanus*) and cliffrose (*Cowania mexicana stansburiana*), the nozzle would not fit over the branches to draw the seed off the plants. If the seed was dislodged by wind or hand shaking the bushes, the air amplifier collector readily picked the seed up off the ground.

An advantage of the amplifier is its ability to harvest seed on windy days. It is also easier to get unexperienced seed collectors to use this seed harvester than collect seed by hand.

Collecting forb seeds at Ephraim, Utah, with air amplifier seed collector.

Disadvantages:

- Collection nozzle must be placed over each branch on stem to harvest seed. Branches on most shrub species do not permit this.
- Collection areas must be close to a road or the land must be fairly level and free of gullies to permit vehicle travel.
- Cost of renting or purchasing an air compressor.

Recommended changes:

- Increase airflow.
- Decrease distance from mouth of nozzle to airstream.
- Increase diameter of nozzle.

We feel the air amplifier seed collector has possibilities in harvesting native land seed and warrants further development.

Air Amplifier Seed Collector Trials

By Stephen B. Monsen, Forest Service

Field trials using the vacuum seed harvester were conducted in Idaho during January 1979. The machine was used to collect seed of fourwing saltbush *Atriplex canescens* and shadscale saltbush *A. confertifolia*.

The tests were performed at a time when the seeds had fully ripened, dried, and were in prime condition for collection. Trials were made about midday. At this time, the plants were dry and little moisture occurred on the bush. Consequently, the seeds were brittle and fell from the shrubs rather freely.

No attempts were made to compare the amounts of seed collected by the air amplifier seed collector with hand collection or other methods of collection. The first trial tests were performed to determine if the machine was capable of harvesting seeds without damage to the plant or the seeds.

The suction required to remove the seed from the plants and draw material into a collection bag is developed from a large compressor. Field trials were conducted using a 75-cfm unit. The compressor was mounted on a small trailer and towed into the field with a pickup truck. Only one size compressor was used in this initial test.

Positive Features

1. The suction created by the machine was adequate to collect seeds of both species of *Atriplex*. The machine was not capable of dislodging seeds from all bushes. However, once the seeds were loosened, the machine could easily draw the material into the collection bag. Seeds of fourwing saltbush are rather large and relatively heavy when compared to other dry-seeded shrubs. Consequently, the machine appears capable of harvesting a number of other species. Seeds that are light or fluffy—rabbitbush, sagebrush, spirea—could easily be harvested with this machine.

The air amplifier seed collector performed very well in harvesting seed of shadescale saltbush. This shrub is particularly difficult to collect by hand as numerous spines occur on the plant. These spines interfere with hand collections.

2. Seeds drawn through the machine and into the collection bag were not damaged. The machine does not break or fracture seed appendages. Only small twigs or leaves were drawn into the bag as seeds were collected. The amount of debris accumulated was rather small when collecting from either species of saltbush. Approximately 6 percent of the material collected in tests with fourwing saltbush consisted of twigs or other debris.

3. The collection unit is a simple lightweight machine. The prototype model is well built with few features that require service or maintenance. With the exception of the compressor, the unit can be constructed at minimal cost.

4. Seeds are drawn directly into a sack attached to the machine. As the sack is filled, the bag can be replaced with another empty sack. The operator can replace the bag without having to empty the container. This is a good feature, and certainly eliminates bagging problems.

5. The collection head and tube through which seeds are drawn into the machine are of adequate size. Seed and debris are not lodged in the tube, but move freely into the collection bag. This is often a problem with other seed collection equipment.

6. The machine can be easily serviced. Few or no sections require attention. Problems can be easily detected.

7. The machine does not create dust or undesirable working conditions. The operator does not encounter problems that occur when small gas engines are carried on the back of the collector. The noise level is low, and the operator is able to communicate and detect field problems that may arise.

Negative Features

1. Because the machine relies on a compressor to operate, the unit is confined to areas accessible to motor vehicles. The machine can be operated in cultivated fields or rangelands where a vehicle can travel. A high-pressure hose is attached from the compressor to the collection unit. The operator must drag the hose over brush, rocks, or other obstacles. This, of course, interferes with and delays collection. Two individuals are needed: a person to operate the seed collector and a driver to move the vehicle and compressor.

The backpack unit, with the attached hose, is not heavy. A single individual can collect the seed and maneuver the hose without difficulty. The unit is well-balanced and can be carried without stress; even if the collection bag is full with 10 to 15 pounds of seed.

The machine is relatively maneuverable even with the constraints of the hose and compressor. Consequently, it is possible to collect seed of single bushes of a species being harvested without hazard of mixing. Field-planted nurseries could be easily collected with the machine. Wildland stands are also easy to collect, assuming a vehicle can be driven into the area. The most obvious constraint with this unit is the inability to operate in inaccessible areas.

2. The flex tube and grip-type handle that the operator must maneuver in seed collection are rather large, bulky, and tiring to operate. The flex tube could be reduced in size and weight. A squeeze-type handle is attached at the end of the collection tube. The operator uses this handle to control the air suction and sweep the nozzle across a plant. An extension should be added to the end of the tube. This would allow the operator to reach across a large bush with greater ease. The operator would not be required to move so often to reach all portions of the shrub. The operator must now stoop and bend to reach low growing plants. These plants could be easily reached with a longer nozzle attachment.

3. Although seeds were freely drawn into the machine, the force or suction created by the compressor was not able to completely dislodge all seeds. Seeds not fully ripened, or that may adhere to the plant, must be dislodged before being drawn into the bag. It was necessary to strike the branches of fourwing saltbush with a small paddle to first dislodge the seed. This can also be accomplished by striking the seed branches with the nozzle of the seed collector.

Some of the fourwing saltbush seeds dislodged with a paddle fall to the ground. The operator is unable to maneuver the nozzle fast enough to catch all the falling seeds. Seeds can be picked up from the ground, but additional debris also is collected. As an operator becomes more proficient with the machine, fewer seeds are lost during collection. Although tests were not performed, it appeared that fewer seeds were lost

by hand collection than with this unit when collecting fourwing saltbush.

In trials with shadescale saltbush, fewer seeds were lost when collecting with the machine than when collecting by hand. The nozzle can usually be positioned over the branches causing seeds to be dislodged and sucked into the collecting bag. Seed recovery appears to be better using the machine than is achieved by hand collection.

4. The unit appears to be useful in harvesting seeds of various species. Seeds of fourwing saltbush can be collected faster and cheaper by hand collection. However, the machine can collect seeds of shadescale saltbush faster than by hand methods. Other species with related seed characteristics could also be better collected with this machine.

5. Further tests will be made of other species as seeds mature.

Two modifications will be made before conducting further field tests: (1) adding an extension nozzle and, (2) replacing the ring-type clamp that holds the collection bag onto the machine. The clamp is awkward to remove and can easily be corrected with a quick-coupling device.

Lightweight Seed Collector Development at SDEDC

By Dan W. McKenzie, Forest Service

The Forest Service San Dimas Equipment Development Center (SDEDC), working with the Seed Harvesting Workgroup, is conducting a project to develop lightweight seed collecting equipment. The workgroup suggested that SDEDC consider technical changes, design alternatives, and new concepts because the marginal performance of the two SDEDC prototype backpack seed collectors did not justify their fabrication for field use. Field tests of these prototypes resulted in the following criteria for a lightweight seed collector:

- *Minimum* air velocity of 7,000 fpm. (While some seeds can be collected at less than 7,000 fpm, most require an air velocity that is as high as possible, but not less than 7,000 fpm.)
- Seed separation *must* occur before material reaches the fan, with no seed passing through the fan.
- Inlet size of 3 to 4 inches would be ideal; from 1 to 6 inches might be acceptable.
- Minimum seed storage of ½ cubic foot.
- Maximum weight to be carried of 34 pounds, with controls within easy reach of the operator.
- If unit is equipped with an engine, it must have a spark arrester and a fuel shutoff valve. There must be no fire-causing hot spots.
- Maximum sound level of 85 dBA at either of the operator's ears; if sound level at either ear exceeds this, muff-type hearing protectors must be worn and then the maximum sound level at either ear can be 115 dBA.
- Reasonable cost per unit.

Based on the above criteria, SDEDC is working on three new concepts, and one major design alternative, for a lightweight seed collector. The first new concept is easy to use: an injector seed-collecting head (air amplifier) powered by compressed air (80 to 100 psi) agitates and then collects the seed in a sack. Two collectors have been fabricated, one with a 3-inch opening and one with a 6-inch opening. The 3-inch size has undergone limited field testing; the 6-inch size is ready for testing. They are limited in the distance they can be taken from a road by the need for an air supply from a large air compressor—40 cfm for the 3-inch and 100 cfm for the 6-inch size. Air inlet velocities for these units are approximately 10,500 fpm (119 mph). Cost of the unit is about \$550; operating costs will probably be high (\$20 to \$40 per day for the air compressor alone).

The second new concept uses an injector nozzle (from Solo of Germany powered by a commercial air broom. Inlet velocities of 9,000 fpm in the small-diameter (1¼-inch) hose have been observed; the small diameter is the main disadvantage of this approach. The unit weighs only 24 pounds; its performance is comparable to a household vacuum cleaner. So far, field testing by California State University, Fullerton, is disappointing on most seed species. Cost of the unit is low (approximately \$300); operating costs also are low.

The third new concept is a seed-collecting head nozzle for an air broom. We hope it will be almost as effective as the head in the first concept. By combining the effectiveness of the compressed air powered injector seed-collecting head with the lightweight of the air broom, this seed collector should be both effective and one-person portable. Cost is estimated to be about \$600 per unit; operating costs should be very low.

The major design alternative to the SDEDC prototype backpack seed collector is to modify the design and mount it on a small cart so that a person can push it around instead of backpacking.

OSU Seed Harvester Developments

By Richard W. Whitney, Oklahoma State University

Field testing of the Oklahoma State University (OSU) grass seed stripper was continued during the 1978 season. Improvements to the harvester included the addition of another material handling fan and separator, a sacking chute to aid in collecting samples, and a

camera mount to assist in taking movies of the stripping reel action.

Treatments for the 1978 tests included two forward speeds, 3.9 and 5 km/hr and three reel speeds: 400, 550, and 700 rpm. Three locations in Oklahoma were harvested: Ardmore, Chickasha, and Leedey. All three were fields of plains bluestem provided by cooperators. In addition to evaluating the machine variables, comparison was made with an AC "66" combine at Ardmore, and with a 21-foot Baldwin Gleaner combine at Leedey.

Figure 1 summarizes the results of the 1978 tests regarding the effects of reel rpm on harvesting efficiency. (Data for each forward speed have been averaged.) Observation indicated that efficiency varied significantly with maturity and yield. The tests at Ardmore were conducted 2 to 3 days prior to optimum harvest date. The tests at Leedey occurred approximately 2 to 3 days after optimum maturity. Increasing reel rpm increased percent of yield harvested in most tests. Above 550 rpm there was a tendency for further increases in efficiency to diminish. Comparison with the combine shows the stripper performed better at higher reel speeds.

Seed purity averaged 55 percent for the combine and varied from 22 to 45 percent for the stripper (fig. 2). Although forward speed had an effect, the main influence on purity was reel rpm. Optimum appears to be about 550 rpm.

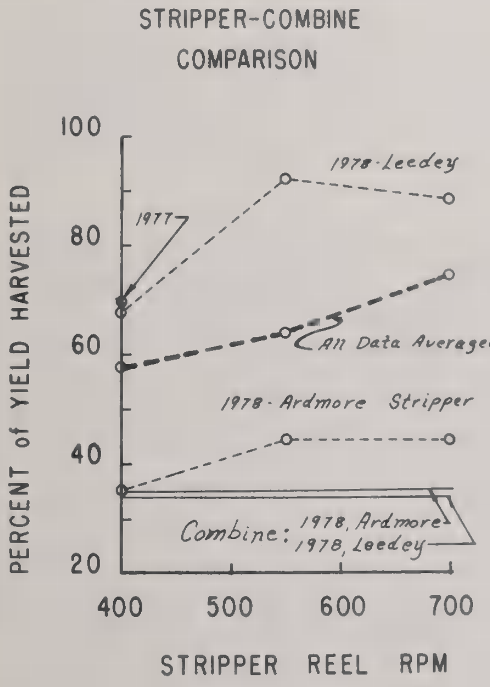


Figure 1—Effects of reel rpm on stripping efficiency with associated combine data.

Moisture content of harvested plains bluestem (fig. 3) was observed to be about 45 percent for the com-

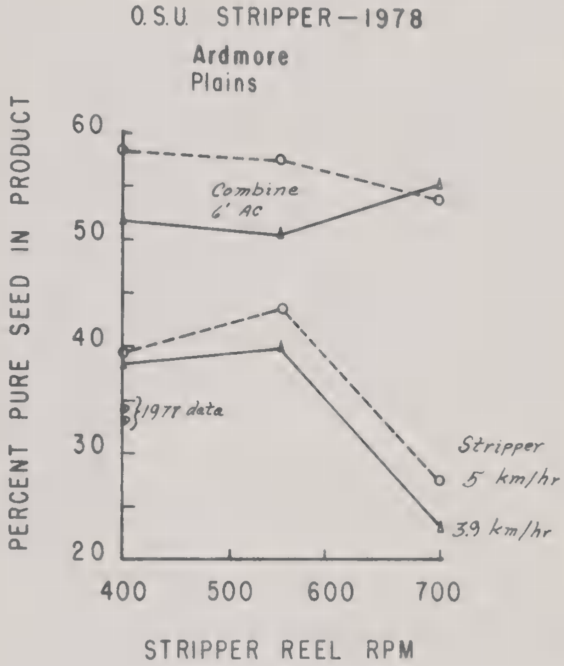


Figure 2—Effects of reel rpm and forward speed on product quality with associated combine data.

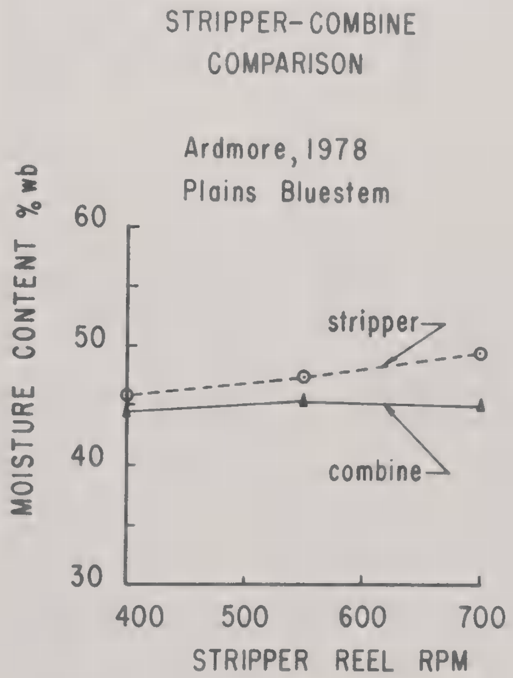


Figure 3—Observed moisture content of machine-harvested plains bluestem.

bine and 2 to 3 percent higher for the stripper. A slight increase in moisture resulted from increasing reel speed. This was evidently due to a higher percentage of stems being stripped at the faster speeds.

Conclusions

A compromise must be made regarding reel rpm selection because increasing reel speed tends to increase harvesting efficiency but decreases the pure seed content in the product. It appears that a reel speed of approximately 550 rpm would be a reasonable choice because good harvesting efficiency begins to occur at that speed, and stripping aggressiveness is still below that which results in low product purity.

Moisture content of plains bluestem harvested with the stripper exceeded that of the combine by 2 to 3 percent and increased slightly as reel speed was increased (fig. 3).

1979 Work

Activity planned for 1979 includes the design of a cleaner to process stripper harvested seed and evaluation of the OSU stripper in other grass species.

Kincaid Equipment Manufacturing, Haven, Kans., will be developing the stripper for production and sale. Prototype units will be evaluated during 1979, with full-scale production scheduled in 1980.

Seeding and Planting

Dick Eckert, *Chairman*

(Reported by Dan W. McKenzie)

Workgroup Activities

1. Field tests of the interseeder for rocky and brushy areas (ED&T 2532) were continued at the Ephraim, Utah, location and also conducted near Boise, Idaho, where almost 600 acres were seeded. Richard Stevens, Utah Division of Wildlife Resources, has prepared a report on the testing at the Ephraim location and Stephen Monsen, Forest Service, Intermountain Forest and Range Experiment Station, has prepared a report on the testing near Boise.

2. The Utah Division of Wildlife Resources has operated a Whitfield forestland transplanter for planting shrubs and is reported on by Richard Stevens.

3. Modification and repair of rangeland drills and brushland plows is being carried out by the Bureau of Land Management District Office at Vale, Oreg., and is reported below by Ethan Freeman.

4. The manufacture of the rangeland drill, brushland plow, contour furrower, seed dribbler, and land imprinter is being done by the Laird Welding & Manufacturing Works, Merced, Calif., and is reported by Roy Laird of that company.

5. Physical soil modification by deep ripping is being carried out by Agristruction, Inc., Ososi, Calif., and is described by Gus Collin, P.E., president of Agristruction.

Interseeder for Rangelands

By Richard Stevens, Utah Division of Wildlife Resources.

Funds were provided for this work by Federal Aid in Wildlife Restoration through Project W-82-R.

An interseeder was designed by the Forest Service San Dimas Equipment Development Center (SDEDC) for scalping and seeding rangelands. A report was given last year on the design of the complete interseeding system, field testing programs, and recommended modifications.

This past year, three types of scalping equipment were tested for their effectiveness in removing perennial grass competition and creating an environment for the successful establishment of 16 different shrub and forb species. The scalping equipment types were single-disk trencher, Sieco fireplow, and modified Hansen scalper-seeder. Scalping and seeding were conducted in a stand of intermediate wheatgrass (*Agropyron intermedium*) and desert wheatgrass (*A. desertorum*).

Scalping and Seeding Results

Success of a scalper was measured by rate of reinvasion of the surrounding established perennial grasses into the scalp. Scalping and seeding occurred in the fall

of 1977. Results are from data collected at the end of the first growing season. Reinvasion of grass into the scalp was measured by counting the number of grass culms from the center of each scalp to its edge. Counts were made along six 2-inch parallel strips on each side of the center of the scalp. Total area covered was 24 inches, 12 inches on each side of the center.

The modified Hansen scalper made a scalp about 28 inches wide and 4 inches deep in the center. A scalp 30 inches wide and 9 inches deep at the center was made with the Sieco fireplow. The single-disk trencher scalps were only 20 inches wide and 8 inches deep in the center.

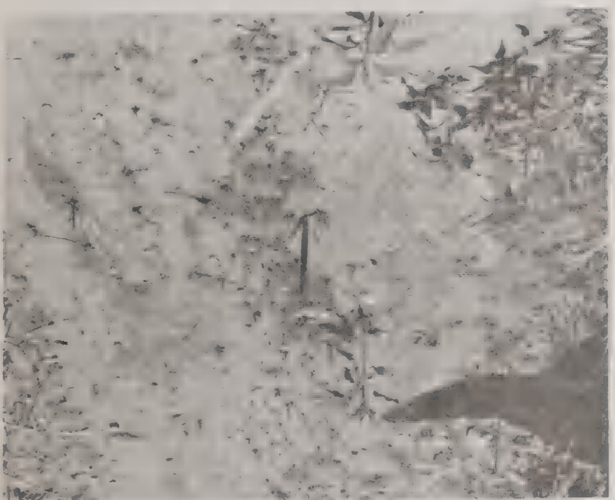
Reinvasion occurs from the edge to the center of each scalp. The Sieco fireplow had the least amount of reinvasion with the single-disk trencher the greatest, and the Hansen scalper in between (table 1). Reinvasion is occurring at a very fast rate in the single-disk trencher scalps, and the scalps that are the most narrow. At the present rate of reinvasion, it will only be a matter of years until the single-disk trencher scalps are full of perennial grasses. After evaluating the first year reinvasion results, we rate the effectiveness of the Sieco fireplow in removing competition as best.

Overall seeding success was also best in the Sieco fireplow's scalps with an average for all seeded species of 5.22 seedlings per linear foot. The Hansen scalper had 4.46, and the single-disk trencher scalper had 3.09 seedlings per linear foot.

Most successful results were obtained from valley big sagebrush (*Artemisia tridentata tridentata*) and mountain sagebrush (*A. tridentata vaseyana*), prostrate kochia (*Kochia prostrata*), alfalfa (*Medicago sativa*), Lewis flax (*Linum lewisii*), showy goldeneye (*Viguiera*

Table 1.—*Grass culms per square foot along 2-inch parallel strips 1 year after scalping and seeding in three types of scalp*

	Center of scalp out to 2 inches	*2 to 4 inches from center*	*4 to 6 inches from center*	*6 to 8 inches from center*	*8 to 10 inches from center*	*10 to 12 inches from center*
Sieco fireplow	0.19	0.19	0.25	0.27	0.63	0.73
Hansen scalper	0.17	0.23	0.40	0.65	0.71	3.06
Single-disk trencher	0.27	0.21	0.41	1.44	6.63	—



Seedlings of mountain big sagebrush in a Sieco fireplow scalp.

Seedlings of Lewis flax in Sieco fireplow scalp.

multiflora), chickpea milkvetch (*Astragalus cicer*), and small burnet (*Sanguisorba minor*). Fair results were obtained from white rubber rabbitbrush (*Chrysothamnus nauseosus albicaulis*) and mountain rubber rabbitbrush (*C. nauseosus salicifolius*), and Pacific aster (*Aster chilensis adscendens*). Few seedlings of bitterbrush (*Purshia tridentata*), cliffrose (*Cowania mexicana stansburiana*), and fourwing saltbush (*Atriplex canescens*) were found.

Seedlings of a mixture of white rubber rabbitbrush, mountain sagebrush, valley big sagebrush, prostrate kochia, Lewis flax, and alfalfa seeded into a Sieco fireplow scalp. Scalp was made in a full stand of intermediate wheatgrass and desert wheatgrass.

Seedlings of small burnet in a Sieco fireplow scalp.

Fifteen acres were scalped and seeded to a mixture of six shrub and forb species. Excellent results were obtained in scalps made with the Sieco fireplow. Very poor results were obtained in the single-disk trencher scalps.

Modifications and Further Testing

A double-disk trencher was obtained and field tests were conducted. The double disk made scalps 24 to 26 inches wide. Preliminary results indicate that double-disk scalps are inferior to Sieco fireplow scalps.

Trouble was again encountered with the turbocharger blowing seals. It is recommended that the air transport system be modified so that air movement is accomplished with a 12-volt fan system rather than the turbocharger.

Dan McKenzie and Walter Moden replaced the venturi tube with a transvector airflow amplifier that improved airflow and seed movement.

Rangeland Interseeder Field Trials

By Stephen B. Monsen, Forest Service

The interseeder was used to plant approximately 600 acres of rangelands in southern Idaho during the fall of 1978. The machine was primarily used to interplant shrubs into existing vegetation at two principal locations. A mixture of grasses was included with shrubs in a seeding conducted near Fairfield, Idaho. About 10 acres were seeded at this site. Plantings were made within a deteriorated stand of alkali sagebrush (*Artemisia longiloba*). At the second and largest planting, near Bliss, Idaho, the machine was used to interseed shrubs into existing stands of crested wheatgrass (*Agropyron desertorum*). About 580 acres were planted at this location. At both sites a Sieco medium fireplow was used to clear or create the planting furrow. This furrower is equipped with a leading Coulter disk followed by two side disks. The unit is designed to clear a swath approximately 30 inches wide.

At the Fairfield site, alkali sagebrush occupied about 40 percent ground cover. The understory vegetation of grasses and herbs provided less than 15 percent cover. Alkali sagebrush is a low shrub, usually growing less than 2 feet high. However, it has an extensive root system and was growing on a rocky site. The interseeder was used to eliminate or reduce competition from existing plants and introduce more desirable species. The interseeder was drawn through the area creating furrows about 8 feet apart. The planting site was not treated with any other equipment prior to planting.

At the Bliss site, the interseeder was also used to reduce competition but primarily from established stands of crested wheatgrass. The wheatgrass had been seeded onto the range sites many years ago. A dominant or nearby pure stand of grass occurred on most sites. The plants were deeply rooted and uniformly spaced throughout most areas.

The seed mixture planted at the Fairfield and Bliss locations is listed in table 1. Species planted at both sites were introduced to improve the forage and cover resources. Lightweight seeds were included in both plantings—big sagebrush (*Artemisia tridentata*), rubber rabbitbrush, (*Chrysothamnus nauseosus*), and common winterfat (*Ceratoides lanata*). All seeds were cleaned to a high purity to reduce problems encountered in seeding.

The prototype interseeder, constructed at the Forest Service San Dimas Equipment Development Center and mounted on a John Deere 350 crawler tractor, was used in these trials. Only minor modifications were made to the machine.

Table 1.—*Seed mixture planted at two Idaho locations using the interseeder*

Species	Fairfield	Bliss
Grasses		
Fescue, hard sheep	1	—
Ricegrass, indian	0.5	—
Wheatgrass, crested	1	—
Wheatgrass, intermediate	1	—
Wheatgrass, pubescent	1	—
Wheatgrass, streambank	1	—
Wheatgrass, tall	1	—
Wildrye, Russian	1	—
Forbs		
Alfalfa	1	—
Aster, Pacific	0.5	—
Burnett, small	2	—
Flax, Lewis	1	—
Shrubs		
Rabbitbrush, rubber	2	1
Saltbush, fourwing	3	4
Sagebrush, big	—	1
Sagebrush, black	2	—
Winterfat, common	1	—
Totals	20	6

Earlier tests reported by Stevens, et. al., 1978,[1] described the construction and operating systems of the seeder. Trials at the two Idaho sites were conducted to assess the following objectives:

- Usefulness of the machine to reduce shrubby competition and interseed adapted species.
- Ability of the machine to be used as an interseeder in planting woody species within established stands of wheatgrass.
- Durability and operative capabilities of the machine when used in planting extensive acreages.
- As possible, determine operative costs of interseeding to compare with other methods of planting.

Site Preparation in Woody Vegetative Types

The machine performed satisfactorily in treating the alkali sagebrush sites. The furrower opener was capable of digging uniform strips even amid large rocks. The 350 tractor could be geared to run at a desired speed, and the digging depth of the planter could be properly controlled to adjust to the rocky nature of the site. Large rocks were often overturned without damage to the machine. The scalper could be maintained at a proper digging depth without serious stress or damage to the equipment. Although solid rocks were sometimes encountered, no major equipment damage occurred. The digger usually is forced or pulled out of the ground as large obstacles are encountered.

Although the equipment was sometimes operated over extremely rocky sites, the seeding device continued to function satisfactorily. Seed was distributed at a desired rate, with little or no gaps in delivery.

The scalper uprooted the alkali sagebrush within the width of the scalp. Most shrubs were sheared off at ground level or uprooted. It is doubtful these plants will recover. The 30-inch scalper may have been too narrow to sufficiently reduce competition between existing shrubs and the young seedlings established by interseeding. Studies will be continued to determine plant survival.

A series of chain loops were used as drags to cover soil over the seed. Sections of chain were attached to follow the seeder and cover the seed.

The cannister or seed dispenser that was built to direct the seed into the furrow was replaced with a long extension tube. We found the tube "blew" the seed outward over the entire scalped area. This appeared to result in better seed coverage. Often seed that was otherwise placed in the confines of the narrow furrow was not always covered with soil. Soil near the center of the scalp is often compacted by the seeder or scalper. The soil is usually not so compacted near the outer portion of the scalp. The drag chains usually rough up the soil along the sides of the scalped area giving better seed coverage.

[1]Stevens, Richard, 1978. Interseeder for rocky and brushy areas (ED&T 2432). *In* 32nd annual report, Vegetative Rehabilitation and Equipment Workshop, Aug. 1978, p. 6.

The machine was able to interseed about 10 acres in a 4-hour period, or approximately 2.5 acres per hour. Based on an operating cost of about $20 per hour for the machine and operator, the treatment costs were about $8 per acre (table 2).

Table 2.—*Interseeder operating costs for treating two vegetative types*

Vegetative types	*Operating rate (acres treated/hr)*	*Costs/Acre Equip.*[1] *& Oper.*
Woody site	2.5	$8.00
Wheatgrass site	3.5	$5.71

[1]Equipment costs based on $28,000 purchase price for John Deere 350 crawler tractor and interseeder. Unit is prorated at .0419 percent per month.

Interseeding Shrubs into Established Stands of Grass

The interseeder easily uprooted mature plants of crested wheatgrass and created a desirable planting furrow for shrubs. Grass sod is often difficult to uproot, but the interseeder did a satisfactory job. Digging or scalping the grass at a depth of approximately 3 to 4 inches was required to uproot mature plants. This involves moving or side casting a substantial amount of soil. The interseeder performed well and could be operated at a reasonable speed. The machine was able to interseed between 25 to 30 acres per day or about 3.5 acres per hour. In some areas we were able to treat 40 acres in an 8-hour period. Furrows were made through the grass at approximately 10-foot spacings. Average costs for treating the grass sites were less than $6 per acre for the equipment and operator (table 2).

The scalper overturned and cast most of the grass sod out of the furrow. Few grass plants fell back into the furrow. Consequently, the scalp area was usually cleared of competitive plants.

Seeding Mechanism

The thimble seeder dispensed the shrub seed mixture very well. Approximately 8 pounds of mixed seed was applied per acre (table 1). The rate of seeding was easy to regulate. The operator could observe the seeder, and could adjust the machine as needed.

Seeds metered out of the thimble seeder are blown through a long extension tube to the back of the planter. Shrub seeds were easily blown through the tube to the outlet. A major problem with the seeder was the operation of the turbocharger. This unit creates the draft needed to blow the seed through a long tube to the furrow. The turbocharger developed an oil leak that could not be corrected, even though the unit was replaced. Similar problems were encountered in earlier trials conducted in Utah by Stevens, et. al., 1978. This problem recurred and could not be corrected. Unless this can be rectified, a small electric motor should be used in place of the turbocharger.

We found the machine to be adequately built and able to operate under adverse conditions. With the exception of the turbocharger, the machine does not require extensive maintenance. It is capable of clearing thick grass sod or woody plants and interseeding a variety of seeds of different size and shape. Further tests and minor modifications should be made. Consideration should be given to:

- Replacing the turbocharger with an electric motor.
- Testing a wider scalper or furrower openers.
- Interplanting in other mixed vegetative types, including sites dominated by annual weeds.

Tree Transplanter for Transplanting Shrubs into Rangelands

By Richard Stevens, Utah Division of Wildlife Resources

Funds were provided for this work by Federal Aid in Wildlife Recreation through Project W-82-R.

Some big game and livestock winter ranges in the West are dominated by annual and perennial grasses. Many of these areas do not have adequate habitat cover or needed forage variety. Shrub species need to be established in these grass stands that will provide winter and spring forage and escapes or thermal cover for big game and livestock. Two means are available for establishing desired species: direct seeding and transplanting.

Direct seeding is an acceptable practice in establishing desirable forage. However, the time between seeding and usable forage is often extensive. In an effort to establish shrubs and trees quickly, transplanting was investigated.

A number of tree transplanters have been developed. Four different makes and types were tested on range sites. The heavier built the transplanter, the greater was the success. Best results were obtained using a Whitfield forestland tree transplanter. None of the automatic feeding and planting systems tested worked well. Automatic feeds were continually being plugged with rocks, debris, and plowed-up soil and plant material. Because many shrubs have rather fibrous or large root systems, they were not picked up or released as they should have been and were therefore not planted properly.

Forestland tree transplanter.

Transplanting was done at two locations. One area was a stand of intermediate wheatgrass (*Agropyron intermedium*) and desert wheatgrass (*A. desertorum*); the other, a stand of native Salina wildrye (*Elymus salina*).

Scalping was first accomplished using the Sieco fireplow and then running the transplanter down the scalp. This, of course, required two passes and was time consuming. A scalper was built and connected to the transplanter directly behind the tractor. The prime mover was a John Deere model 350 diesel engine, crawler tractor with an implement-carrying hitch developed by the Forest Service San Dimas Equipment Development Center.

Scalping and transplanting were performed in the fall of 1977. At the end of the first growing season, percent survival of bare root transplants was only 33 percent using the automatic feed and plant system. Survival success for bare root stock planted by a man riding a transplanter was 95 percent. Even though the forestland tree transplanter was not designed for hand planting, it can be accomplished, although with much discomfort to the planter. A very heavily built hand-fed tree transplanter has been obtained from the Utah Forestry and Fire Control and is being modified to fit the Forest Service-designed implement-carrying hitch.

Transplanting container stock through the forestland tree transplanter by hand worked very well on species that have root systems that extend to the bottom of the containers and were fibrous enough to hold the rooting medium together. Survival success for container stock was 61 percent.

Bare root stock is much easier to transport and transplant than container stock, and survival success is usually greater. Good bare root is preferred over container stock for transplanting into rangelands.

Species with exceptional survival and growth were mountain sagebrush (*Artemisia tridentata vaseyana*), big sagebrush (*A. tridentata tridentata*), Woods rose (*Rosa woodsii*), Siberian elm (*Ulmus pumila*), tatarian honeysuckle (*Lonicera tatarica*), black chokecherry (*Prunus virginiana melanocarpa*), Peking cotoneaster (*Cotoneaster acutifolia*), winterfat (*Ceratoides lanata*), lilac (*Syringa vulgaris*), and white rubber rabbitbrush (*Chrysothamnus nauseosus albicaulis*).

For best transplanting results, roots of bare root stock should be at least 6 inches long and not longer than 12 inches. Tops should be over 3 inches long so the planter can get a good hold on them and place them as needed.

Transplants of mountain sagebrush and big sagebrush put in by hand through a forestland tree transplanter.

Transplants of Peking cotoneaster put in by hand through a forestland tree transplanter.

Modification and Repair of Rangeland Drills and Brushland Plows

Presented by Ethan W. Freeman, Bureau of Land Management

The Bureau of Land Management (BLM) District Office at Vale, Oreg., has been designated as a repair center and pool for BLM rangeland drills and brushland plows. The Vale District has a large, well-equipped shop with experienced mechanics to modify and repair the equipment. With the closing of the Forest Service Depot at Stockton, Calif., the Vale District is probably the only noncommerical source for specialized repair or replacement parts for rangeland drills and brushland plows.

About 50 drills and 16 plows are available in the pool for loan to BLM Districts and to other agencies on request, with BLM having priority. Normally, many more drills are available than those in the pool through other BLM locations and from the Forest Service and the Bureau of Indian Affairs. On many occasions, the Vale District has determined availability and coordinated user needs.

A recent inventory shows these agencies have 220 full-size standard rangeland drills and 52 brushland plows. With this number available, the most critical demands of a large fire rehabilitation program can normally be met with a coordinated effort. Unless other type drills are needed (such as the deep furrow rangeland drill), the inventory indicates that Federal agencies need not purchase additional drills. The only two known sources of standard or deep furrow drills or special range seeding drills are Laird Welding & Manufacturing Works and Metal Masters, Inc., both in California.

The Vale District modifies and repairs up to 140 rangeland drills and 6 brushland plows each year, depending on fire rehabilitation needs. All drills and plows are updated to standardize the equipment. This makes repairs easier and more economical, improves usability, reduces skill level necessary for field opera-

tion, and makes drills easily interchangeable between various users. Major modifications being made to the drills and approved by the Forest Service San Dimas Equipment Development Center are:

- Using a Universal hitch. This hitch was adapted from a Letourneau scraper hitch and is a heavy clevis-type that swivels in all directions. Freedom of movement is allowed in rough terrain which has practically eliminated hitch breakage. Drills can be pulled by wheeled or crawler tractors, either singly or in multiples with the Universal hitch and the drill cart multiple hitch.
- Placing seed tubes over the disk spindle to reduce seed tube plugging.
- Improving lubrication capabilities.
- Installing improved, more durable bearings.
- Installing bracework on seedboxes and drill frames.

The Vale District will modify and repair this equipment, billing requesting agency for the work. If personnel and hauling equipment are available, the District can arrange to transport the equipment. But we prefer that the requesting agency arrange the transportation. For additional information on the service and repair of equipment, contact:

Bureau of Land Management
Vale District Office
365 A St. West P.O. Box 700
Vale, Oreg. 97918
Phone (503) 473-3144

Rangeland/Brushland Equipment Manufacturer

Presented by Roy Laird, Laird Welding & Manufacturing Works

The Laird Welding & Manufacturing Works, Merced, Calif., manufactures rangeland drills, brushland plows, contour furrowers, and seed dribblers. The company also repairs and furnishes parts for this equipment. In addition, Laird has received the rights to manufacture the land imprinter developed by Bob Dixon, Science and Education Administration, Southwest Rangeland Watershed Research Center at Tucson, Ariz. Units will soon be available for delivery.

In the past year, some changes have been made to the rangeland drill. The tongue of the drill has been changed from channel iron to 6-inch by 2-inch rectangular tubing and a triple-seal ball bearing requiring no lubrication is now standard on all opener disk shafts manufactured after October 1978.

As optional equipment, Laird can now furnish the heavy clevis-type hitch with double swivel developed by the Bureau of Land Management at Vale, Oreg. As a replacement for the standard hitch the cost is $182.50 and as a separate item, $318. Also as optional equipment, the rangeland drill can be equipped with a hydraulic-operated opener arms lift attachment. This attachment allows the arms to be lifted hydraulically with 24-inch clearance by the operator when making a turnaround, when crossing or transporting on a road, or when backing up. When installed at the Laird plant or furnished as a kit for field installation, the cost is $1,235 f.o.b. Merced, Calif.

A universal mounting bracket is now furnished with all seed dribblers for mounting the seed dribbler on a crawler tractor. The bracket allows the dribbler to be mounted on either the right or left side of the tractor and on tractors with or without fenders. (An additional bracket may be required on some tractors without fenders.)

Physical Soil Modification

Presented by Gus Collin, P.E., President, Agristruction, Inc.

In 1934, soil problems impeding agricultural development in the San Joaquin Valley (central Calif.) created the birth of Agristruction, Inc., (formerly Collin Co.). Soil improvement through physical modifications has been the specialized goal of this firm. With the demand for new agricultural land, where permanent, deep-root crops could be grown, deeper breaking of hardpan and mixing of soils has become necessary. The increased size of tractors (in both weight and horsepower) has made greater ripping depths both possible and economical. In cooperation with the University of California, increased growth rates of both deep- and shallow-rooted crops were found to be achieved with a homogenous soil profile, allowing root growth and water drainage.

Conventional ripping equipment had been built for the mass market of road construction, but not for the specific needs of agriculture. Therefore, Agristruction has designed and manufactured deep-ripping equipment for the unique needs of the agriculture industry. First, a ripper that would penetrate the hardest material and maintain a constant depth was developed. A large, towed 45,000-pound ripper was constructed, as were new shank and point designs. After developing a ripper that would penetrate the ground and withstand the loading, the problem of pulling it had to be solved.

Multitractors were used to fulfill this need, since deep ripping could be accomplished much more economically by using several tractors and ripping the required depth in one pass (rather than multipasses with a single power unit). Also, less damage to the surface soil was done when ripping was accomplished in one pass. Next, various shank angles were experimented with to increase efficiency and maintain depth.

Quadripper with 9-foot capacity.

A requirement unique to agriculture is the necessity to rip a straight line—primarily for trees and vines. To accomplish this, a steerable ripper shank was designed that operates similar to a rudder on a boat. A vineyard or orchard can be layed out and then ripped straight down each row.

A Quadripper was designed and built in 1972 to ease moving between fields, reduce turning time, and increase efficiency. The Quadripper uses two Caterpillar D-9's in tandem that serve as one tractor with one operator. A weight transfer ram is located between the tractors to increase traction. The ripper attachment surrounds the second tractor, with the hitch point between the two power units. The second tractor pushes while the front tractor pulls. The hydraulic ram on the back power unit has 100,000 pounds of down force and 9 feet of ground clearance, enabling ripping to a 9-foot depth. At 1 mph, the Quadripper has 200,000-pound drawbar pull and can be pushed by a second set of Caterpillar D-9's, also hooked together in tandem, resulting in over 400,000-pound drawbar pull at 1 mph. One, two, or three shanks can be used in the ripper carrier. Disassembly or reassembly of the Quadripper can be accomplished in less than 1 hour with standard tools, and the entire unit can be moved on two lowbeds.

Other attachments that can be pulled by the Quadripper are a slip plow, a 30-foot toolbar, and a chisel. The slip plow is used in lighter soils to mix the subsoil and eliminate any barriers to vertical water movement. The 30-foot toolbar can be used for shallow ripping to depths of 32 inches.

The Quadripper can rip in hard soils with seismographic velocities of over 15,000 feet per second. Previously, a reading over 12,000 fpa was considered unrippable. The weight, horsepower, pulling and steering ability, and ease of moving, as well as greater ripping capacity, make the Quadripper more flexible than the D-10 for physically modifying soil.

Tandem Caterpillar D-9's push Quadripper, giving 400,000-pound drawbar pull at 1 mph.

Thermal Plant Control

Bill Davis, *Chairman*

(Reported by Harold Edwards)

Thermal Brush Control (ED&T 2168)

Recommendations made at the 1977 annual meeting basically consisted of (1) continued testing and (2) constructing an additional machine.

Testing continued in 1978 with a conclusion that we should investigate a fuel type other than propane. Propane contains considerable water and fuel lines tend to start freezing up after about 1 hour of operation. Propane is awkward to use as supply is often a considerable distance from the worksite and requires special handling and transfer equipment. It is the opinion of some that propane has additional safety disadvantages over a less flammable fuel such as No. 2 diesel.

Design concepts for a new lightweight machine have been started. Jim Tour of the Forest Service Missoula Equipment Development Center has been assigned to this project. He has inspected the present machine and interviewed users. It is proposed that construction will be financed in fiscal year 1980.

Improved Aerial Ignition System

An improved method of setting prescribed burns and controlling wildfire through aerial ignition is available. A new fuel, a mixture of gasoline thickened into a gel, has been developed that is a reliable and efficient fire starter. Unlike previous gas-diesel fuel mixtures, which tend to burn out or break up before reaching the ground, the gelled gas holds together and keeps burning as it falls through the air.

The gelled gas is dripped out in golfball-sized lumps from a "helitorch" suspended from a helicopter cargo hook. The helitorch consists of a tank capable of carrying 55 gallons of gas and 10 pounds of gelling agent similar in texture to laundry detergent. The pilot controls the flow and ignition of the gel. The helitorch is in the pilot's sight at all times and can be jettisoned should anything go wrong.

The new gel enables pilots to drop fire with greater accuracy from higher altitudes and faster speeds, increasing safety and efficiency. It also eliminates the dangers of sending ground crews into heavy brush to set fires by hand.

The gelled gas is less volatile than past mixtures and can be dropped at speeds up to 55 mph from heights of 500 feet. The helitorch can operate continuously for up to 5 minutes. Tests on the Mendocino National Forest in California showed that the helitorch ignited a chapparal-chamise brushfield in 3 minutes that would have taken an estimated 8 hours using ground crews.

The gelled-gas helitorch was developed in 1978 by Western Helicopter Services, Inc., of Newburg, Oreg. (The original helitorch, using a gas-diesel mixture, was developed several years ago in Canada, but was little used in the United States.) Western has applied for a patent on the system and arranged for manufacture by Simplex Manufacturing Co. of Portland, Oreg. The equipment has received the approval of the Federal Aviation Administration.

Simplex manufactures and sells the helitorch for about $3,200. According to Western, burning costs with the helitorch range from $3 to $12 per acre in logging slash, however, costs will vary considerably depending on the vegetation. Western's specifications show the helitorch uses 1.5 to 3 gallons of fuel per acre and is capable of firing 100 to 200 acres per flight hour.

"Helitorch" uses newly developed fuel—gasoline thickened into a gel—for reliable, efficient aerial ignition.

Mechanical Plant Control

Carl M. Rice, *Chairman*

(Reported by Dan W. McKenzie)

The Forest Service San Dimas Equipment Development Center (SDEDC) has published a report on heavy-duty mechanical brush cutting and slash treatment equipment. Information from 12 sources on 23 different precommercial thinning and slash treatment machines is presented along with field use data on 12 of the machines. Criteria for selecting the most appropriate equipment are also discussed. A list of heavy-duty mechanical brush cutter manufacturers with their addresses and telephone numbers was included in the 1978 VREW annual report. A copy of the SDEDC report is being mailed to everyone on the VREW Information Workgroup mailing list.

Report on heavy-duty mechanical brush cutting equipment.

Chemical Plant Control

Ray Dalen, *Chairman*

Herbicides have been aerially applied on rangelands for many years, using a wide variety of equipment and materials. Even with today's greater concern for environmental safety, it appears such spraying will continue, with more effort directed at the evaluation of the various spray systems to determine their advantages and disadvantages.

On many projects, aerial application is the most practical technique. But the principles of aerial application of herbicides under wildland conditions are not always fully understood by field personnel. Spray drift off the target area, which may result in reduced effectiveness and environmental damage on adjacent areas, is a prime concern. A great deal of research and development is directed toward finding practical ways to reduce drift. However, much of the information is not in a form useful and available to field people.

To help solve this problem, a contract was awarded to Norman B. Akesson, University of California at Davis, to prepare a handbook to help field people who plan and supervise aerial herbicide application projects. The handbook covers project operations and safety, application equipment, meteorology, principles of drift control, spray drop spectrum selection, spray pattern assessment, and related topics. A review draft was received and is now being edited, with publication and distribution planned for late 1979.

Technical Standards

Don Mellgren, *Chairman*

(Reported by Ted Russell)

The Technical Standards Workgroup was established at the 1977 annual meeting in Portland, Oreg. The workgroup was formed to investigate the need for sponsoring the certification of all educational institutions west of the 100th meridian engaged in reclamation technology programs.

In the past 2 or 3 years, a number of educational institutions throughout the United States have established reclamation technology programs. These rec tech programs generally are of 2 years' duration, and the student is issued a certificate identifying him as a reclamation technician. Sponsorship for these programs is nonexistent now. As a result, no guidelines or minimum standards for instructors, curriculums, or facilities have been developed. This lack of standardization has resulted in considerable diversity in the quality of talent graduating from these programs.

Soon after the Technical Standards Workgroup was formed, it was discovered that other land reclamation associations also were concerned with the certification problem. The American Council for Reclamation Research has included in its bylaws provisions for working with educational institutions to help improve reclamation technician programs. With this organization and others involved in the problem, it was decided at the Casper, Wyo. meeting to abolish the Technical Standards Workgroup. Any future activity on the part of the VREW involving technical standards will be handled by the Disturbed Land Reclamation Workgroup.

Structural Range Improvements

Ron Haag, *Chairman*

The primary emphasis of the Vegetative Rehabilitation and Equipment Workshop since its conception in 1946 has been with vegetative manipulation and related activities. Workgroups are specialized, oriented primarily toward development of equipment and materials for nonstructural improvements. There has been no organized effort to evaluate and develop improvement facilities necessary to manage the vegetation once it has been improved.

The Steering Committee has established a new workgroup whose primary function will be to identify National needs for structural and other range improvements. This workgroup's charter is to:

- Develop a current assessment of structural and other range improvement problem areas.
- Serve as a "clearinghouse" for all proposed projects relating to structural improvements.
- Serve as a recommending body to the Steering Committee for funding proposed projects.
- Work with the Information Workgroup in the dissemination of technical information regarding structural improvements.

During the upcoming year, the workgroup will be spending its effort in the following areas:

- Workgroup organization.
- Development of a process to solicit and prioritize projects.
- Formalization and submission of a project for assessing problem areas relating to structural improvements.

Windmill Counterbalancing Modification

Presented by Ethan W. Freeman, Bureau of Land Management

At the Vale District, Bureau of Land Management, our water systems specialist and other personnel, have developed a windmill counterbalancing system that will improve windmill efficiency from 50 to 80 percent plus. We have used this on both Aero Motor and Dempster towers, and it should work on any standard tower.

The modification reduces needed continuous wind velocities from 10 to 12 mph to 4 to 5 mph. This means not only that existing windmills are more dependable water sources, but also that many areas with lower wind velocities can be opened to windmill water production.

With this system we can counterbalance the total weight of the sucker rod, and up to one-half the weight of the water column.

With a gaged hydraulic cylinder attached to the pump rod and the sucker rod, we determine these two weights. We then used springs of the proper tension, attached to the frame near the top of the windmill tower and to the pump rod to obtain the desired or practical counterbalancing effect.

Devices to Improve the Safety, Simplicity and Economy of Working with Windmills

Presented by Ethan W. Freeman, Bureau of Land Management

Windmill Tower Hinge. Assembling and installing the head and fan on the tower is safer and easier with the tower down. Also to make major repairs to the windmill head or fan, or to pull the well tubing it is either necessary or easier and safer to lay the tower down.

We accomplish this by hinging the tower and using

a well hoist truck to raise or lower the tower. The tower is anchored to a pickup truck on the opposite side to stabilize the speed of tower movement when it breaks over center. The hinge consists of 1-inch black pipe welded to the anchor plate in the tower base, and connected to the tower by a 5/16-inch by 3-inch by 6-inch iron strap welded and bolted to the tower legs.

Windmill Tower Trailer. We built the trailer out of an implement trailer. By attaching angle iron to the trailer frame, corresponding to the angle of a windmill tower, we can position the tower snugly on the trailer. It is then clamped securely to the trailer. A hitch is clamped to the head base at the top of the tower. Stop lights and turn signals are attached to the base of the tower, and hooked to the pulling vehicle.

We are working on a Tech Note covering these developments. I hope it will be out before next fall.

For additional information, contact:

Bureau of Land Management
Vale District Office
365 "A" St. West
P.O. Box 700
Vale, Oregon 97918
(Phone (503) 473-3144)

Papers

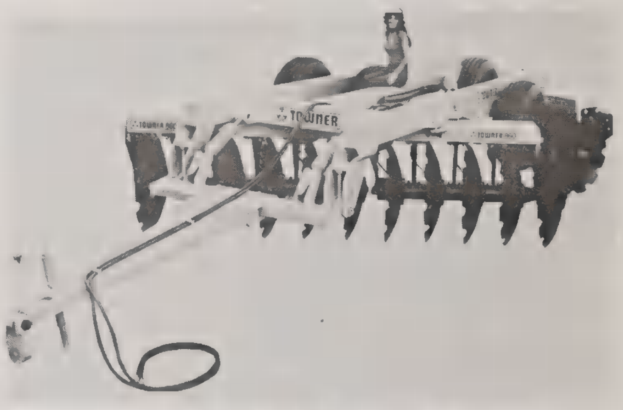
Towner Plowing Disk Harrow

Wally Parmeter, *Towner Manufacturing Co.*

The Towner 860 series wheel-type offset disk harrow, offered in four models, is a heavy-duty, deep-plowing disk implement for all types of deep plowing and tough cutting. It is wheel mounted and has 40-inch diameter disks on 16-inch centers. Depth of cut can be varied from approximately 2 to 16 inches.

The implement can apply 1,300 pounds per foot of cut to virgin ground, resulting in up to 85 percent kill of all brush and small trees in one pass. The 860 can be pulled by crawler or large-wheel tractors. To avoid flat tires, the disk harrow should have industrial puncture-resistant tires; wheel tractors used with the 860 should have 30.5 x 32 single steel-belted tires.

If seeding is to be accomplished in addition to plowing, an "Easy-Flow" type seeder may be mounted on the rear gang of the harrow. The seeder can be hydraulic motor powered by the pulling tractor hydraulics. This permits the seeder to be turned off when not in use.



Towner 860 disk harrow with 40-inch-diameter blades that penetrate to 16 inches.

Spreaders and Associated Equipment for Reclaiming Surface Mines

Don Estes, *President, Estes Equipment Co., Inc.*

I wish to thank you for inviting me here to speak to you today. I feel that I should at least relate to you how I have become involved in the development of machinery that is used in surface mine revegetation and finally into the actual revegetation process.

I established the Estes Spreading Co. about 1955 when the interstate highway construction began in Kentucky. After several years of working with conventional lime spreaders, I felt there must be a better way to spread lime on steep slopes than to have a bulldozer pull the spreader up and down the slopes and over high cuts. In 1967 I began developing a lime spreader that would have more capability for area application. The first of these machines was used in 1969. I later had five or six of these trucks in operation, liming interstate right-of-ways during the revegetation phase.

The original lime truck was much the same as today's version. However, according to what a particular cus-

tomer might need in his operation, tnese spreaders can be customized for special conditions. The spreader can be loaded at the quarry or on the job. Screens are placed on the top to eliminate large foreign objects or oversized rocks.

These spreaders differ from conventional lime spreaders because they are equipped with a directional thrower. This thrower is powered by either a gasoline or diesel engine. The directional control allows the operator to throw either dry or damp lime up onto highway cuts, surface mine highwalls, and down on steep highway fill or head-of-hollow fill areas on surface mines. The lime spreader is also equipped with a set of spinners at the rear to allow lime spreading on flat areas that are easy to drive on with conventional trucking equipment.

For extremely difficult areas where only tracked vehicles can operate, lime spreaders of this type have been mounted on low center of gravity trailer frames. The controls are designed to mount on the tracked vehicle console and allow the tractor operator complete control.

While working on the revegetation of highway right-of-ways, I also felt that the application of straw for mulching was a time-consuming and expensive operation when so much bark was available, if it could be applied. However, no satisfactory bark spreading equipment had been developed. I then began to see if the lime spreader could be modified in some way to allow a production bark spreading machine. The first machine that I built capable of spreading bark was completed in the fall of 1972.

The University of Kentucky heard that I had developed this bark thrower and visited me to discuss its potential for the revegetation of surface mines. We visited a number of the sawmills located near the mining operations. We found their waste piles to be a problem to them since they could no longer burn this material due to newly enacted clean air legislation. The bark was being piled out anywhere a place could be found and was becoming a potential water pollution source as well as being an "eye sore" on the landscape. These waste piles, however, appeared to be an untapped source for a material that could help solve many revegetation problems on surface mine areas.

We began our first trials in the spring of 1973. The bark was trucked to the surface mine and loaded into the bark thrower with a front-end loader. The spreading was accomplished with no difficulties when the bark used had been removed from the trees with rosser head debarkers and not contaminated with other wastes from the sawmill. The material covered the ground in a uniform manner and resulted in rapid revegetation. Good covers of grass and legumes were established in 5 to 6 weeks without any rain during the period. The vegetation remained green and rapidly growing a year later, even during the normal dormant month of August.

However, we experienced many problems using unprocessed bark. The material tended to become contaminated either at the sawmill with metal or large pieces of wood or on the mine with large rocks. Even when this problem was overcome, the bark occasionally tended to bridge in the hopper when the bark was too large and not uniform in size.

We experienced these problems in research plot establishment not only with the University of Kentucky, but also with the other agencies that were conducting research in revegetation.

It was generally felt that, for this bark thrower to be a success, the bark would have to be processed to a uniform size and all foreign materials removed that could damage the thrower unit. We knew that such material could be generated from a hammermill installation at the sawmill. However, to get a sawmill operator to make such a commitment, a contract would have to be made to take all his waste for a number of years. This was not a suitable alternative at that time since no actual revegetation operations were located in any area that would take all production from a single source.

Bark is ground before mulching to eliminate large pieces of woody material that could damage spreading equipment.

We then investigated the possibility of using a Farmhand tub grinder. This machine has been successfully modified to handle bark materials. It allows processing onsite and has resulted in a system that will rapidly load the bark thrower. The uniform particle size from this grinder has resulted in blowing rates that more than double the potential treatment area per day when applications are made at the State recommended rate of 45 cubic yards per acre.

We have since found that this sytem also allows us to mix other organic materials with the bark. We have

Bark mulch is being applied on a surface mine site with and Estes Spreader.

enriched bark using this grinder with sewage sludge, chicken manure, and other waste products. The University of Kentucky has applied such material to surface mines in Kentucky and finds it is out-performing any other mulching system to date.

We have also had great success spreading a material called "Real Earth." Real Earth is a composted municipal garbage and sewage sludge mixture produced in Norman, Okla. The bark thrower easily blows this material because it contains no large particles. It has a uniform spreading capability and tends to promote rapid vegetation on very harsh sites. Excellent stands of grass and legumes have been established on sites where no vegetation has grown before using prior methods of seeding.

Usually in such areas we will also use tractors and chisel plows to first incorporate the lime and fertilizer. Organic materials such as Real Earth, bark, bark and chicken manure, or other suitable mulching materials are then incorporated and over-blown with the seed.

We now feel we should further the consideration of waste material use to include vegetative material found on site prior to mining.

Until now the trees on the mining site have been bulldozed off and either burned or covered over by the spoil. We would like to see the usable material sold as wood products, such as logs and chips, using limbs and tops to produce mulch chips on the site.

This material can be processed much like bark. The chips are ground in the tub grinder and used either alone or in a mixture of organic materials. The chips are loaded into the thrower trucks the same as the bark. This material has a very good flow rate since it contains no foreign objects and does not tend to bridge in the hopper. It has a uniform spreading pattern and appears to adequately enhance moisture and temperatures on surface mine spoil.

We have progressed rapidly in developing machinery to aid in the revegetation of disturbed land areas. I am sure that there will be many more in the future. I know this to be true, since I and others around the world are interested in seeing our industrial age problems become mutual solutions that can result in a better world for this generation and generations yet to come.

Reclamation: Innovations and Directions at the Rosebud Mine

Chris Cull, *Western Energy Co.*

Western Energy Co.'s Rosebud Mine is located near Colstrip in southeastern Montana. The mine has operated under Western Energy's control since 1968 and now consists of three active pits. In 11 years of operation, 56.5 million tons of low-sulfur sub-bituminous coal has been removed. Last year, the Rosebud produced 10.5 million tons of coal, making it the second largest single operation in the country. The majority of our coal is shipped via rail to midwestern utilities.

Colstrip is regarded by many as the energy capital of Montana. Two 350,000-kilowatt coal-fired generators have been on-line since 1976. Construction of two additional power generating facilities, each in the 700,000-kilowatt class, is slated to begin in the spring of 1979. When fully operational in 1983, the energy complex will produce 2,100 megawatts of electricity and consume 7 to 8 million tons of coal annually.

Between production commitments for our midwestern customers and the coal demands of the mine mouth plants, our annual production will increase to 20 million tons by 1984. Commensurate with the increased coal production will be an increase in surface disturbance. Now, we disturb approximately 290 acres each year. By 1984, that figure will rise to 525 acres annually, and the reclamation demands will increase accordingly.

Depending on one's point of view, land reclamation may be considered an art, a science, or an onerous and often unnecessary expense. Reclamation technology in the West is relatively young and is still waiting to be proven workable. At first glance, there would appear to be ample room for innovative and imaginative thinking to further advance the state-of-the-art. Each mining operation has its own unique problems and con-

ditions. Solutions are found either through cooperation with outside research groups or through in-house studies. Western Energy has used both avenues to solve reclamation problems and improve the overall program.

However, the current mining and reclamation regulations have taken a "cookbook" approach in their attempt to "protect" the environment. One result of this approach has been to effectively stifle innovation on the mine site. A possible long-term effect of the explicit regulations may be to curtail technological advancement in the field of land rehabilitation.

But that is another story. What I would like to address today are some of the ways in which Western Energy has contributed to the reclamation effort on drastically disturbed lands. About 2 years ago, Western became one of the first mines to selectively salvage topsoil and subsoil in two distinct operations. This segregation of soil materials was the result of several years of indirect study, field observations, and a touch of common sense.

At the Rosebud Mine, we are required to salvage all available soil. Based on our interpretation of "all available," we use scrapers and dozers to salvage an average of 1.5 to 2 feet of material in advance of the active pit. At least the surface 6 inches is stripped and treated as topsoil. This generally consists of the A horizon or the A and B horizons, depending on the soil development. The subsoil is the remainder of the plant growth medium as determined by premine soil surveys. To the extent possible, the salvaged soil materials are immediately redistributed on regraded spoils. The subsoil is deposited first, followed by a 6- to 8-inch cover of topsoil.

The selective salvage and redistribution has proven quite effective from several standpoints. On postmine slopes that have been topsoiled as described, the extent of sheet and rill erosion is substantially less than that observed on comparable slopes not so treated. Fertilizer inputs, especially nitrogen, are reduced. New vegetative cover tends to be more responsive and vigorous. Species diversity is enhanced due to the germination of viable indigenous seed in the topsoil. Economically, there is no difference in the cost between segregation and nonsegregation of soil materials, because the same total volume of material is moved.

Several seeding techniques have been tried at the Rosebud Mine, including aerial seeding, broadcast seeding, and drill seeding. Until just recently, the regulatory authorities in Montana have specified drill seeding as the only acceptable method. Since 1974, we have used a rangeland drill for the majority of our seeding.

Personally, I don't believe the rangeland drill is very well suited for this kind of seeding. The two major problems are the wide row spacing and the inability to meet the seeding depth requirements of the complex seed mixtures. In most of the areas drill seeded in 1974 and 1975, the drill rows are still evident and the vegetative fill between the rows has been quite slow. Drill seeding tends to concentrate all of the seed in a narrow band. The less competitive species exhibit poor germination and development if they germinate at all.

Based on the preliminary results of a series of native seeding trials conducted by Montana State University, Western Energy Co. relied more on broadcast seeding in 1978. Using a tractor-mounted cyclone broadcaster, we established what we feel were more vigorous and diverse vegetative stands. Broadcast seeding generally produces a more uniform and effective stand that is better able to control early erosion problems.

For the 1979 planting season, we have purchased a Brillion seed packer. Two other mines in Montana have used the Brillion and are very pleased with the results. The Brillion seeder combines the best points of drill and broadcast seeding and eliminates the need for a separate cultipacking operation.

The rangeland drill still plays an important part in our reclamation program. Shrub and forb species do not compete effectively with germinating grasses for available nutrients and moisture. Therefore, we generally exclude these species from our initial seed mixtures. However, the mandate of the law dictates that shrubs, forbs, and trees must be reestablished in the postmine lands. Last year we began an interseeding program aimed at establishing native shrubs and forbs in the reclamation zone. Using the rangeland drill, we seeded selected species individually in predetermined parts of 2- and 3-year-old vegetation dominated by grass species.

It is our hope the interseeded shrubs and forbs will have a better chance of germinating and developing successfully when seeded at a higher concentration in areas where the microenvironment is more acceptable. Because of its basic design, the rangeland drill did not adversely affect the standing vegetation. We will evaluate the effectiveness of our interseeding effort through 1979 and hope to publish the preliminary results in 1980.

Trees, both coniferous and deciduous, have received considerable attention at the Rosebud Mine. We have used a model TS-44A Vermeer tree spade for the past 3 years in reestablishing both trees and shrubs.

Based on transplant survival rates, the operation has been surprisingly successful. Survival of transplanted deciduous shrubs and trees in drainage bottoms has been in excess of 95 percent over the past 2 years. Ponderosa pine transplants, which are generally confined to ridgetops and slopes with north and east aspects, have exhibited survival rates averaging 90 percent for 2- and 3-year-old plantings.

Our attempts to transplant Rocky Mountain juniper

have met with less success. Survival rates of 27 percent on 3-year-old plantings indicate the juniper must be handled differently than ponderosa pine. While the survival of the transplanted trees and shrubs allows for some optimism, we must still wait to see if the relocated vegetation can reproduce and become self-regenerating. Until then, our optimism must remain guarded.

Explicit mulching requirements in the Montana regulations have led to development of new machinery to meet the requirements. The Forest Service's Equipment Development Center in Missoula has successfully demonstrated its modified manure spreader at the Rosebud Mine. Dick Hallman discussed this machine in his presentation.

The manure spreader more than adequately handles the square straw bales. But what does the operator do when only the 1,500-pound round bales are available? We were faced with this problem last spring, and in view of the prolonged winter, may have a similar situation in 1979. We saw a need for some kind of equipment to handle the cumbersome round bales. Last spring, we modified a standard Hesston StakProcessor 10 and have been able to uniformly shred and distribute straw from round bales with a one-man operation.

Modified commercial hay spreader dispenses hay mulch at Rosebud Mine site.

Hydraulic powered "MacFarlane flail" modification insures uniform hay distribution regardless of terrain or wind.

We have dubbed the modification the "MacFarlane Flail" after our mechanical engineer, Bill MacFarlane, who designed the assembly. The basic StakProcessor was built to allow one man to pick up the ¾-ton round bales and then shred and discharge the hay in a windrow for feeding livestock. The bale pickup device is hydraulic, while the shredder and discharge auger operate off the PTO unit.

Our first attempts at distributing the straw with the standard StakProcessor were something less than spectacular. After the straw was deposited in the windrow, we tried to uniformly distribute it by first chiseling and then disking across the windrows at right angles. Needless to say, neither method was effective. It was obvious that something was needed to intercept the straw between the discharge chute and the ground.

Our first thoughts were concentrated on the flail device we have now, but the driving mechanism was different. It seemed reasonable to design the drive system to utilize the power available from the PTO. The system would consist of a relatively complex series of straight and twisted belts and reduction wheels connecting the chute-mounted flail to the main shaft on the StakProcessor.

After considerable paper designing and head scratching, we weren't too excited about our preliminary system. Fabrication of the system would prove relatively expensive because some precision machining would be necessary. The biggest drawback was the inherently high maintenance costs and general unreliability found in complex belt-drive mechanisms.

We had not given a hydraulic system much consideration, probably because it "sounded" both expensive and difficult. As it turned out, it was neither.

The MacFarlane Flail is completely hydraulic and permits positive control from the tractor cab. Two hand controls are located in the cab to the operator's right. One lever controls the speed at which the flail rotates and the other governs the direction of rotation, either clockwise or counterclockwise. The heart of the system is a small, off-the-shelf hydraulic motor manufactured by Charlynn and mounted beneath the discharge chute. The stabilizer mounting bracket that attaches the motor and flail assembly to the chute is the only part that had to be fabricated.

A schematic of the hydraulic system details how the speed and directional controls operate. The rotational direction of the flail is determined by the direction the hydraulic fluid moves through the system. With the lever in the cab, it makes no difference how

the intake or exhaust hoses are hooked up. The flail hydraulics are independent of the hydraulic system that controls the bale pickup.

The device that controls the flail speed is actually a "fluid splitter." Depending on the direction the hydraulic fluid is moving, it enters the splitter through either one of two inlet ports. An indicator lever on the splitter can be moved through positions numbered 0 to 10. The fluid exits the splitter via two outlet ports in a volume ratio determined by the position of the indicator lever.

With the lever set in the 10 position, 100 percent of the hydraulic fluid goes to the flail motor and the rotational speed is maximum, or 1,000 rpm. When the indicator level is on 5, the fluid is split in equal proportions with 50 percent continuing to the motor and 50 percent returning to the tractor. At this setting, the flail speed is one-half that of the number 10 position, or 500 rpm.

Positive control of the rotational speed and direction of the flail allows for uniform distribution of the straw material, regardless of the terrain conditions or direction and velocity of wind. On a well-prepared ground surface that is free of rocks, the tractor can be driven at a relatively fast speed. In such cases, the operator can reduce the flail speed. Where the terrain is rougher or when operating on steeper slopes, the tractor must be slowed down. The operator would then increase the rotational speed of the flail to maintain the same straw distribution. One might say the speed of the flail is inversely related to the speed of the tractor for a given distribution rate of straw.

We have found through trial and error that generally better straw distribution is attained when the flail rotates in a clockwise direction. This tends to throw the straw forward of and away from the StakProcessor. However, when a strong wind is blowing from the rear or into the discharge chute, it seems to be more effective to rotate the flail in a counterclockwise direction.

The entire assembly consists of the fluid splitter, directional control, Charlynn hydraulic motor, stabilizer mounting bracket, flail unit, and about 20 feet of standard hydraulic hose. The flail unit was made from reinforced rubber strips attached to metal holders at the motor. We used 4 rubber strips measuring about 24 inches in length cut from 1-inch belting. The cost for the assembly was less than $400, including materials and labor.

The only modification we have made on the flail assembly was to extend it farther out on the discharge chute. In the original position, part of the straw would miss the rubber flails as it was augered out the chute. We fabricated an extension for the mounting bracket that allowed us to use longer rubber strips and still avoid hitting the StakProcessor body. The modification has proven quite satisfactory, and we have had no breakdowns or other than ordinary maintenance on the flail assembly.

Between the MacFarlane Flail and the Modified Manure Spreader, we now have the capability to handle either square bales or the large round bales. Indications are we may be seeing more of the round bales in the future. Certainly there are advantages and disadvantages with either method. The square bales stack better than round bales and require less area. The MacFarlane Flail is a simple and relatively fast one-man operation while the manure spreader is slower and may require 3 or 4 men to handle the loading.

I mentioned earlier the opportunities for imaginative and innovative thinking in addressing land rehabilitation problems. Looking into the future, I can see the need for developing new or modifying existing equipment. A few examples would include transplanters to handle 2- to 5-year-old nursery stock, sod cutting or range scalping equipment and transporters, and improved equipment to remove and transplant indigenous shrub pads.

As the rules and regulations governing western surface mining and reclamation become more explicit and stringent, those of you who are frustrated inventors should be stimulated and challenged.

In a manner of speaking, we have seen the birth and childhood of a strong and needed industry. We can look eagerly toward the adolescent stage in which our earlier labors will be refined and polished. Unfortunately, certain overzealous individuals and special interest groups are beginning to replace reclamation and rehabilitation with terms like preservation and restoration. If the trend continues, equipment development could be curtailed. The economic and environmental framework may be so confining that our industry will go straight from childhood to early senility.

Affiliation with Other Land Reclamation Organizations

Farnum M. Burbank, *Forest Service*

VREW has been approached by two other land reclamation organizations with regard to affiliating with them. This was discussed at last year's meeting to get group feelings. Also, it was reviewed again with the Steering Committee and the Exploratory Workgroup during the year.

The first proposal was from the American Council for Reclamation Research (ACRR), (formerly the Council for Surface Mining and Reclamation Research in Appalachia). Their proposal was to combine with them into one national organization with Western and Eastern sections. Each section would retain its individual identity (other than name), functions, and overall objectives. Coordination would be carried out through designated liaison representatives in each group. Last year, VREW seemed to react favorably to such an affiliation, but decided to further consider the proposal.

In December, we received additional correspondence on this matter from ACRR. The VREW was again invited to join with ACRR in a national organization. The ACRR also sent a copy of its bylaws. It is apparent that ACRR has a much more formal organization than VREW and it was the consensus of a number of our people that it was beyond the scope of our inherent informality. Therefore, Chairman Ted Russell recommended that we retain our present status and place coordination activities with our Disturbed Land Reclamation Workgroup (East) chaired by Willis Vogel. There was general approval of this recommendation.

The other organization was the Canadian Land Reclamation Association (CLRA). We had correspondence from this group at least a year ago inviting us to formally affiliate in an international federation of reclamation associations. To date, we have made no formal commitment to CLRA. I attended its annual meeting in Sudbury, Ontario, in June 1978. I had the opportunity to visit with the officers, gain an understanding of their organization, and explain VREW. They are even more organized than ACRR, having a constitution and bylaws; they have even incorporated. They now publish a periodic journal, the *Reclamation Review.*

Again, in this case, I see very little way that our structure would allow a formal alliance with CLRA. Therefore, my recommendation is that we establish a communication channel, possibly through someone in VREW who may also wish to join CLRA. We would distribute information to our people through our VREW mailing list. Technology exchange with them would benefit both groups. I passed out to a few attendees membership information on CLRA. I believe that the general reaction of our meeting attendees favored this approach.

I further recommend that our Chairman relay our feelings in writing to both of these organizations. I will coordinate with him in this regard.

Also, during this year, I have been made aware of several other associations that have interest in land reclamation. It has been suggested that we try to compile a list of these and publish them in our annual report. I only know of a few, so I solicit information from anyone knowing of such groups. I received none from the February 1979 meeting attendees. I really believe this could enhance technology transfer in this area and possibly avoid redundancy.

Public Law 95-87 and Reclamation Implications

M. J. Cwik, *Dames & Moore*

Extensive areas of altered landscapes due to mining activity in the United States have been comprehensively documented in several recent reports.[1] Affected States have been aware of these for some time as evidenced by the widespread enactment of State mining legislation and regulations.[2] Only within the last year, however, has national attention been brought to bear on this topic with enactment of the Surface Mining Control and Reclamation Act of August 3, 1977 (Public Law 95-87).

This act reflects a national awareness that the coal mining industry has value other than the more obvious one of coal extraction for purposes of producing energy. This act recognizes the industry is no longer a mineral exploiter only, but also a husbandman faced with the task of caring for the water, air, animals, and plants entrusted to it.

Public Law 95-87 is a unique piece of Federal legislation compared to other Federal environmental legis-

[1]Paone, James, John L. Morning and Leo Giorgetti, 1974. Land utilization and reclamation in the mining industry, 1930-1971, Info. Circ. 8642, USDI, Bureau of Mines, Division of Ferrous Metals--Mineral Supply, Washington, D.C.

Paone, James, Paul Struthers, and Wilton Johnson, 1978. Extent of disturbed lands and major reclamation problems in the United States, chapter 2. *In* Reclamation of drastically disturbed lands, ASA-CSSA-SSSA, 677 South Regoe Rd., Madison, Wis. 53711.

[2]Dames & Moore, 1976. Legal controls of surface mining, vol. III, Development of pre-mining and reclamation plan rationale for surface coal mines, U.S. Bureau of Mines, Open File Report No. 100(1)-76, 209 p.

lation enacted in the last 10 years. The National Environmental Policy Act of 1969, Clean Air Act of 1970 and Amendments, Federal Water Pollution Control Act of 1972 and Amendments, Toxic Substances Control Act of 1976, and other environmental legislation place administrative and enforcement responsibility in the broad-based U.S. Environmental Protection Agency. Furthermore, these pieces of environmental legislation are generally indiscriminate in their application, since they apply to a wide variety of governmental and industrial activities.

In contrast, Public Law 95-87 created a new Federal agency, the Office of Surface Mining Reclamation and Enforcement (OSME), which administers and enforces regulations of the act that apply to a specific group, the surface coal mining industry.

A second unique aspect of the act is that its created agency, OSME, has the potential of becoming a very powerful and important Federal regulatory agency. This is because the office, which ultimately is planned for a work force of 850 people, is charged with enforcing environmental protection performance standards identified in regulations prepared in compliance with the act. These performance standards describe in almost exhaustive detail requirements for preserving or restoring the integrity of the air quality and the hydrological and biological environment. Engineering design and biological restoration techniques that are required in surface coal mining are described in exhaustive detail and, in some cases, even quantified.

One other unique aspect of Public Law 95-87 is its position of being a springboard to regulate the entire surface mining industry. In section 101, subparagraph (i), of the act, Congress has found that data and analyses are needed to serve as a basis for regulation of noncoal mining operations. Furthermore, title III of the act finds that substantial money is designated in the act for instruction and research in mining for minerals other than coal. The act even forms a new advisory committee on mining and mineral research to supervise this effort. Without question, then, the 1977 Surface Mining Control and Reclamation Act is a significant and powerful piece of Federal legislation.

The act provides for both an initial and permanent regulatory program. The initial regulatory program is to be in place until the State program has been approved by the Office of Surface Mining and Enforcement or until the Federal program has been implemented for a State that fails to submit a program within 18 months of the enacted date of the statute (August 3, 1977) or fails to resubmit an acceptable program within 60 days of OSME's disapproval of a proposed State program. OSME has 6 months after submission of a State program to approve or disapprove the program. Therefore, it will take 2½ to 3½ years from August 3, 1977, to have a permanent program in place.

Public Law 95-87 has created a need for suitable reclamation expertise by many mining concerns. The reclamation consultant provides a valuable service to these mining companies. Since the principal purchasers of environmental consulting services normally have some primary mission other than the protection of the environment per se, it becomes the principal function of the consultant retained by the client to inform that client as accurately and completely as possible of those mining plans—environmental performance standard interfaces—and to give the best possible advice on implications of pursuing various reclamation plans. In this way, the consultant provides for the client's best interests.

More specifically, the reclamation consultant can assist the mine in five areas:

- Perform studies necessary to document alternatives in mining and reclamation plans.
- Advise the mine applicant on environmental measures important to incorporate in the mine plan.
- Prepare the reclamation plan, including experimental designs, equipment of use in mining and reclaiming the mine, suggested field techniques, and alternative reclamation procedures.
- Monitor the mine's reclamation program.
- Participate in public workshops and public testimony on behalf of the mine applicant.

In summary, it appears that Federal regulation of the mining industry is here to stay.

OSME can become a very powerful regulatory agency by virtue of:

- Its single interest focus, i.e., the surface coal mining industry.
- Its enforcement powers that can be exercised across a wide interdisciplinary arena governed by performance standards that are, in many cases, presented in unprecedented detail.
- The potential extension of OSME's responsibilities to the entire mining industry.

The reclamation consultant can assist the industry in complying with Public Law 95-87. A prerequisite to effectively solving the clients problem is proper understanding of the act and regulations and familiarity with continuing court decisions involving litigation pertaining to the act.

Native Plant Materials and A New Plant Center for Testing

Sam Stranathan, *Soil Conservation Service*

Past Vegetative Rehabilitation and Equipment Workshops, directed by "the" authorities in the field, presenting quality information, have been very important. It's an honor to be with you today. It's my pleasure to present a paper on the Upper Colorado Environmental Plant Center and represent all the fine people who have made the Center a successful plant testing facility for the Upper Colorado Region.

People—the public—have come alive about plant materials. It's news—and there is honest concern and support.

Bart Nyberg, Empire Magazine, *Denver Post*, described the Upper Colorado Environmental Plant Center: "The Environmental Garden of Rio Blanco County—a locally financed plant center helping energy companies put the shale and coal country back together." *Colorado Rancher and Farmer* editor Carl E. Carlson wrote in his lead paragraph: "Performance—that's the elusive prize for which researchers at the Upper Colorado Environmental Plant Center continually search. The technicians are sifting through hundreds of grasses, legumes, forbs, and shrubs to find vegetation most suited for a wide range of land use needs in the Upper Colorado Region."

Relative to responses of governmental interests, Lynn Whiteman of the UCEPC Administrative Board is quoted as saying, "no finer example of interagency-interdiscipline cooperation exists."

The Meeker, Colo., area is quality country. One of the nation's major elk herds and a major migratory deer herd call it home. Ranching, farming, and outfitting have been its dominant industries. These are factors common to the Upper Colorado Region in varying degrees.

Now undeveloped, underground minerals are changing the area's complexion. Mineral development activities are changing soil and plant communities over significant areas, changes that influence the quality of the environment for humans as well as wildlife.

The EPC is not billed as the savior of the Upper Colorado Region. However, the Center is a hotspot—a focal point to accelerate development of regionally specific information needed by private landowners, energy producers, and State and Federal land managers.

At our last Advisory Committee meeting, Gordon Van Epps, Snow Field Station, Ephraim, Utah, relieved some contention about the new Center when he said, "In view of the different environments and vegetation we are dealing with, duplication is something we can stand until we get over some of the pitfalls." Though some duplication exists, the EPC places high priority on native species' evaluation and selection. Other general activities relate to quality seed increase of species important for our area and the development of the cultural techniques associated with harvest, production, and successful planting.

Our top long-range program objectives are to select plant materials capable of having a positive impact on:

- Revegetation of alpine and subalpine disturbed lands.
- Restoration of processed oil shale.
- Revegetation of coal mined lands.
- Improvement of big game habitat.
- Roadside stabilization and site beautification.
- Rangeland seeding in low rainfall areas.
- Revegetation of disturbed lands (other than mined lands).
- Perfecting a method for using turf-type plants for stabilization.

A point of significance relates to our operation and to many of you. According to decisionmaking authorities at the State level, the term "native plant" becomes undefinable in general terms. Consequently, with the advent of mining laws, definitions of longstanding terms like "exotics," "introduced," "indigenous," and "native" are as evasive as the end of the rainbow.

The production of "native species"—we call it seed increase—is one of our major activities. We are interested in getting quantities of high-quality seed available to users in our region. We are growing "Redondo" Arizona fescue, Great Basin wildrye, "Bromar" mountain brome—all plants produced by the outstanding plant materials program carried out by the Soil Conservation Service.

Our seed and the knowledge gained about its production is then made available to landowners and commercial producers interested in producing a volume of certified seed for the market. This activity is coordinated with the Colorado Seed Growers Association and Soil Conservation Districts.

Next spring we will plant seed increase fields of "Nezpar" Indian ricegrass, "Montane" mountain mahogany and "Bandera" Rocky Mountain penstemon.

Due to the slow process of shrub maturity and seed production, we have a "seed orchard" of regionally collected materials. These materials are new and under

initial evaluation. The best will be selected and used for seed and spring wood production. Our advisers recommended we plant 190 accessions of 55 species of 31 genus in this orchard.

Because we hope to have superior ecotypes of a large number of species, we plan on supplying commercial growers with seed materials so that: (1) they can plant their own orchards, and (2) they can produce live plants from seed in quantities adequate to meet annual demands until their own orchards are productive or a commercial source is available. Final details of this arrangement are not completed.

Our industry advisers say, "to purchase adequate amounts of high quality seeds of acceptable species is nearly impossible." They try to use commercially available materials, but not many of those species meet the specific revegetation requirements of their site. Regionally acceptable materials currently under test might not hit the market for years under the previous formal release process. This logjam was confronted by our Advisory Committee, which assigned a committee to develop a system applicable to Colorado for woody species seed and plant certification.

Mr. Sheldon Ladd, agronomy, Colorado State University, and Mr. Wendell Hassell, plant materials specialist, Soil Conservation Service, authored a system that has been adopted on a 3-year trial basis. It certifies, according to definite standards, materials into three categories: certified, select, and source identified.

The problem of getting plant materials into commercial markets is important to all of us interested in revegetation. Past history has shown, no matter how important a tested material is to a specific need, if the material can't be produced at a profit, it will not be produced.

The bulk of EPC resources are directed at initial evaluations. There are 31 projects carried out by EPC staff, 25 occurring on the Center's 189 acres. Over 3,000 materials have been submitted by field people of the Soil Conservation Service, Forest Service, Bureau of Land Management, Fish and Wildlife Service, private industry, ranchers, and State universities in Wyoming, Colorado, and Utah.

We evaluate stratification processes for each species, recording success through germination and seedling stages. The plants are hardened off and grown at 6,500 feet under 16 inches of annual precipitation and a 90-day frost-free season on silty clay loam soils.

Plots are evaluated twice a year for survival, vigor, growth, and browse. In one project we compared over 1,700 different grasses for the routine factors plus seed production and regrowth vigor. In 1978 we selected top grasses and clipped for forage production values. The grasses in the project have multipurpose uses. Other projects include irrigated and dryland native and introduced grasses, forbs, legumes, vines, and shrubs.

The Center is subject to outside influences. Geese and sandhill cranes visit the EPC, with ducks and sage-hens hatching out young. Deer and elk use the plots. We've nearly been plagued by the rabbits and ground squirrels. Of course, the rodents attract the eagles and hawks. Wildlife have added to our evaluation data.

One easily accessible project has been fall-browsed by deer for 3 years. Our data on deer selection and use have significance. All plots are susceptible to browse and are monitored accordingly.

Last December we monitored the foraging characteristics of the elk as they walked through the fences and utilized the snow-covered plants. Forty-three elk found our dryland legumes, in part, to their liking. They preferred to dig out specific rows of the irrigated wheatgrasses, smooth brome, and orchard grass.

In addition to the evaluation work at the Center facility, we have plots on TOSCO lease property in Utah with Joe Merino. These plots of shrubs are influenced by major rodent populations, drought, and limited soil conditions at 5,000 feet elevation. We work with Larry Kline, ARCO, and the ground squirrels on Colony Oil shale plots on Parachute Creek at 7,300 feet. Last summer we set out plots with Bill Dotterrer at the windy Standard Metals gold and silver settlement basins near Silverton at 9,000 feet. Dale Thompson and Rich Atkinson help us with rodent-proof fenced plots near the Colowyo Coal Mine site at 7,300 feet. Plots on reworked coal dumps at the Energy Fuels mine are monitored cooperatively with Kent Crofts. These plots, at 7,300 feet, are influenced by competition from annual plants, marmots, and elk. Needle ice becomes a problem for the plants under test with Ron Zuck at the 11,000-foot-high Climax molybdenum mine.

We are encouraged by early responses of plants like thurbers fescue, mountain brome, and some species of currant. Thurbers fescue is now planted in a small field increase. Other ecotypes of the brome and currant are being collected for a broader comparison so a truly superior ecotype can be identified.

The seed processing and storage facilities are still under development at the Center. Cultural development projects include seed processing and storage, planting methods, stratification, and greenhouse operational procedures. We feel a major responsibility to keep current on available data and develop specific methods and procedures for commercially producing plant materials for the public in our region.

The Center is now completing its building construction and initial field establishment phase. Its owners, the White River and Douglas Creek Soil Conservation Districts, are proud of its development. As a nonprofit

corporation, these men, known as the Administrative Board, have accomplished what few other Soil Conservation Districts would attempt. With strong guidance within their own ranks and pledged financial and technical support from industry, the universities, Federal agencies such as Energy Research and Development Administration, Environmental Protection Agency, Bureau of Land Management, Soil Conservation Service, Forest Service, Fish and Wildlife Service, and the Science and Education Administration, the Center has become a reality. A very impressive Advisory Committee guides the Center in its technical direction. It combines expertise, from every vegetative aspect of our region, with the tested and proven plant materials system developed within the Soil Conservation Service and adopted by the Administrative Board.

The Center works because a lot of people want to see it succeed. We invite you to visit or contact the Center for further details.

Range Renovation Equipment for British Columbia Interior Grassland

F. J. Feistmann, *Finning Tractor & Equipment Co., Ltd.*
(Presented on behalf of the Engineering Branch, British Columbia Ministry of Agriculture)

Introduction

Establishing and maintaining a good stand of grass on the rough terrain and often rocky conditions of B.C.'s interior rangeland is not an easy task and is dependent upon such factors as soil moisture, soil fertility, reseeding method, and grazing management practices.

The method of reseeding is likely the single most important factor in establishing a good stand of the desired species of forage.

Seeding Requirements

The basic requirements for successful reseeding of native rangeland have been established as follows:

1. Good tillage of the top 3 to 4 inches of soil.
2. Elimination of undesired vegetable competition: sagebrush, needle grasses, blue grasses, cheatgrass, etc.
3. Accurate placement of the seed at ½ to ¾ inches deep.
4. Adequate packing to firm the seed into the soil for maximum contact and moisture retention.
5. Durability of the tillage and seeding equipment to withstand adverse terrain and soil conditions.

These requirements sound relatively simple and straightforward; however, they must be carried out under difficult conditions, including rough terrain, proliferation of stones and boulders, tough grass sod, and troublesome vegetation like sagebrush.

Survey of Available Equipment

A great deal of equipment for reseeding range has been developed in many parts of the world. In most cases, the conditions that equipment had to work in was not as difficult as those existing in B.C.'s rangeland.

Many farm-type seed drills have been used for seeding range. Two major shortcomings of this seeding equipment are the relatively light construction and lack of severe contour following ability.

A rangeland drill was modified and fitted with a new hydraulic loading system. This modification resulted in infinite disk force control that would insure proper soil depth penetration yet maintain some seed depth control. However, the unit could not destroy unwanted vegetation completely, and was subject to plugging with heavy stands of sagebrush. Firming of the soil around the seed was not accomplished satisfactorily.

In reviewing range renovation equipment, no units were found to be entirely suitable, but many of them demonstrated principles that could be used to develop suitable machines. It was therefore decided to build two units, a heavy-duty disk and a seeder-packer; both units to be used in tandem for a once-over operation and propelled by a crawler tractor.

Rangeland Disk

The basic design parameters of the disk centered around the individual suspension of disks. The hydraulically loaded suspension of individual disk gangs supplied a number of advantages:

- Infinitely variable loading up to 833 pounds per disk blade, with control at the tractor or crawler seat.
- Extended flexibility to follow severe contours and terrain.
- Extreme flexibility to accommodate obstacles such as boulders and rock outcroppings.
- Increased durability due to having individual sections absorb the impact load on encountering an obstacle, rather than trying to lift the entire machine.

- More freedom from plugging with sagebrush and similar material due to the relative motion between adjacent gangs.

The unique feature of the equipment is the hydraulic control and loading of the individually suspended gangs. Each gang is activated by a hydraulic cylinder. A precharged accumulator and appropriately designed relief valving allow the system to respond to obstacles or alternatively raise the gangs completely for transport. The tractor-mounted pressure bleed valve facilitates on-the-go infinite adjustment of the disk force by establishing the piston pressure relief point.

A brief description of the disk is as follows:

- Tillage width, 12 feet.
- Double offset disk configuration.
- Included gang angle, 50°.
- Maximum subgang width, 3 feet.
- Disk blade spacing, 1 foot.
- Notched disk blade 28-inches-diameter by 3/8-inch-thick.
- Disk force variable from 0 to 833 pounds per blade.
- Minimum disk gang vertical travel plus or minus 1 foot from normal working level.
- Total machine weight, approximately 20,000 pounds or 10 tons.

Rangeland Seeder-Packer

A basic requirement for reseeding rangeland specifies that grass seeds must be accurately placed at no more than ½ to ¾ inch below the soil surface, and the seed must be firmed into the soil for maximum contact and moisture retention.

After good tillage was achieved with the rangeland disk, the soil was compacted with a primary set of rollers. Seed is then metered out onto the well-prepared seedbed, and a secondary set of rollers, offset by one-half press ring width, splits the shallow ridges formed by the front rollers and firms the soil around the seeds.

A brief description of the seeder-packer is as follows:

- Seeding width, 12 feet.
- Brillion-type seeding-packing system.
- Maximum packer subgang width, 3 feet.
- Minimum packer vertical travel plus or minus 1 foot from normal working level.
- Free-floating gangs.
- Minimum compacting load, 280 pounds per foot.
- Packing drum diameter, 3 feet.
- Packing ring spacing, 5½ inches.
- Total machine weight, approximately 18,000 pounds or 9 tons.

A John Deere model 8350 6 by 24 run seed-fertilizer box is carried on top of the main frame. A scaled-up version of the Brillion packer concept was achieved by stitch welding 3-inch by 3-inch by ¼-inch angle iron rings—rolled apex out—to a 3-foot-diameter, 3/16-inch-thick drum. These angle iron press rings are spaced 5½ inches on center.

Both front and rear roller gang assemblies are made up of four drum packer sections. Each of these sections is suspended from the main frame, except for the outside two rollers in the back configuration, which are used for machine stability and transport. The sections are mounted in such a manner that plus or minus 1 foot vertical packer section displacement can be achieved. Seed discharge tubes are located between the front and rear roller gangs.

Work to Date

Fabrication of the heavy-duty rangeland disk was completed in October 1976. Initial tests of the unit were conducted that fall.

Construction of the seeder-packer was completed in April 1977 and initial tests were conducted.

Subsequent testing was carried out and 1,700 acres were reseeded in 1977 with another 3,300 acres being done in 1978.

The ultimate test of any equipment is determined by how successfully the equipment accomplishes its objective. Certainly, modifications had to be made to the equipment during the testing period; however, the fact that 5,000 acres have been reseeded does point to a positive side. We do know the equipment is durable. Further modifications are anticipated for the seeder-packer to increase the bearing life on the packers.

The 1977 and 1978 seedings have all germinated and excellent stands of crested wheatgrass have been established. By practicing good range management, these stands will last for many years to come.

Costs for Renovating Rangeland

A Caterpillar D-6C tractor with approximately 140 horsepower has been used for most of the work to date. On gentle, sloping terrain, adequate power was available to propel this unit; however, when severe slopes were encountered, a relatively new D-7 or the equivalent track layer with approximately 160 horsepower should be used.

Under reasonably good operating conditions, up to 4 acres per hour can be achieved; however, under normal conditions an average of 35 acres per day would be a more realistic figure.

Considerable data were collected during the 1977 and 1978 seasons to arrive at costs involved in renovating rangeland. The following is a breakdown of the various costs encountered:

Labor	$13.12 per acre
Tractor—D-6C	7.90 per acre
Seed	8.00 per acre
Fuel, oil & grease, parts, repairs, moving, etc.	16.11 per acre
Total Cost	$45.13 per acre

These figures do not include interest and depreciation for disk and seeder-packer of $3 per acre.

Certainly these figures will vary depending on the terrain, soil conditions, size of plot, etc. It is anticipated that costs could be as low as $30 per acre and as high as $60 per acre when double disking is required in heavy sodded areas. Under normal conditions $40 to $50 per acre could be anticipated.

Conclusion

The equipment developed to renovate and improve unproductive open grassland range has proven to be effective. Over 5,000 acres of range have been renovated and the growth that has been established looks extremely promising. Certainly one unit could not possibly handle the total renovation potential in the Province, however, a promising start has been made. With good range management practices, the renovation should last for many years and the cost of $45 per acre would seem most reasonable.

A smaller 9-foot model disk and seeder-packer has been designed and built and will be tested in the spring of 1979. This smaller equipment will require a 100 horsepower crawler tractor that is more readily available to ranchers than the larger tractors.

The small unit will be rented to a rancher who will have to supply his own power unit, an operator, seed, and maintain the equipment in reasonable repair. Costs to the rancher have not been fully worked out, however, a nominal charge of $10 to $15 per acre is anticipated.

The intent is to grow more grass in the development of the cattle industry.

Assessment of the Range Disk—Seeder-Packer Equipment in British Columbia

A. H. Bawtree, *British Columbia Ministry of Agriculture*

Successful seeding of poor condition grasslands will at least double the production of usable forage for domestic livestock. Increased production of fivefold or tenfold is not uncommon.

Successful seedings have been difficult to obtain on rangelands in B.C.

Research by Agriculture Canada research officers and others has shown the criteria for successful seedings are:

- Soil cultivation and seed placement.
- Removal of competing vegetation.
- Proper timing of seeding.
- Seeding of adapted grass and legume varieties.
- Soil packing in drier areas.

Soil scarification and seed placement have been our biggest problems. Our rangelands in the southern part of the Province lie between 49° and 52° North latitude. They may be broadly divided into:

- Alpine range at elevations above 5,500 feet.
- Forest range between 3,000 and 5,500 feet.
- Grass and shrub range below 3,000 feet.

Perhaps the best way to describe these ranges is to say they are "uneven" and sometimes steep. All this Province was heavily glaciated and subsequently eroded as the glaciers receded. Our rangeland soils are commonly rocky or sandy or silty. Sometimes there are pockets of deep soils but normally there are only a few inches of soil overlaying rock or gravel.

Native vegetation on the lower ranges is normally big sagebrush or bitterbrush shrubs and a mixture of perennial bunch or sod-forming grasses and forbs. Removal of this vegetation to allow establishment of seeded species is our second biggest problem. Control of the larger woody species is even more difficult. Foresters can be of considerable assistance here, but the stumps still present a problem to soil scarification.

Sod grasses are as difficult as anything to eliminate.

Our first concern for range seedings has been the overgrazed grass and shrub areas. Farm equipment has been used for many years to form an excellent seedbed. Its use is limited to the best sites. More recently, herbicides have proven effective in controlling vegetation but are ineffective in soil scarification and seed placement. Overgrazing can sometimes be used to reduce

competing vegetation prior to seeding. The rangeland drill has been used on many sites and has been the most useful piece of equipment for getting over our rough and rocky rangelands. The main problem with this equipment in B.C. has been insufficient soil scarification and insufficient vegetation control.

The objective of the range disk-seeder-packer is to:

- Accomplish 90 percent soil scarification and control competing vegetation.
- Place seed at desired depth and pack soil around it for more moisture retention.

The first range disk-seeder-packer combination went into operation in the spring of 1977. Since May 1978, we have had a rangeman working full time on assessment of seeding results with this equipment, which has now seeded over 5,000 acres at many different locations. Here are some oven-dried forage production figures obtained from clipping plots at five very different sites at the end of the 1978 growing season. All sites were seeded to crested wheatgrass at between 7 and 11 pounds per acre. None of these sites were fertilized:

Lac du Bois: 50° 45' North; elevation 2,400 feet. Estimated total annual precipitation 13 inches. Seeded June 1977.

Crested wheatgrass	67 pounds per acre
Nonseeded species	1,173 pounds per acre
Total	1,240 pounds per acre

Adjacent unseeded range produced 508 pounds per acre. This is our least successful seeding to date, but we are still hopeful of its ultimate success. The heavy stand of perennial grasses (many of which were sod-formers) and the date of seeding were two factors contributing to the poor results.

Mission: 52° North; elevation 2,200 feet. Total annual precipitation 12 inches. Seeded August 1977.

Crested wheatgrass	686 pounds per acre
Nonseeded species	361 pounds per acre
Total	1,047 pounds per acre

Establishment and production were excellent at this site.

Big Creek: 52° North; elevation 3,500 feet. Total annual precipitation 12 inches. Seeded August 1977.

Crested wheatgrass	484 pounds per acre
Nonseeded species	57 pounds per acre
Total	541 pounds per acre

This is one of our higher elevation sites and is a forest site on which the trees had been cleared, windrowed, and burned. Establishment here was excellent, but production was relatively low. I believe the low productivity can be attributed to the fertility of this forest site.

Bowers: 50° 45' North; elevation 2,200 feet. Total annual precipitation 11 inches. Seeded October 22, 1977.

Crested wheatgrass	499 pounds per acre
Nonseeded species	479 pounds per acre
Total	978 pounds per acre

Native unseeded range produced 128 pounds per acre. Establishment and production of crested wheatgrass were excellent at this site. Nonseeded species, as at most sites, consisted primarily of annual grasses that should be replaced by the perennial crested wheatgrass within a few years.

Similkameen: 49° North; elevation 1,400 feet. Total annual precipitation about 10 inches. Seeded May 2, 1978.

Crested wheatgrass	786 pounds per acre
Nonseeded species	86 pounds per acre
Total	872 pounds per acre

Again we obtained excellent establishment and production. I am particularly impressed with the rapidity of grass establishment at this site, which attests to the suitability of the equipment.

It is reported there are about 96 million acres of sagebrush, primarily big sage, in the Western United States. You can see we have some in Canada also, and you can see the very effective manner in which the equipment has eliminated the sage at these last two sites.

The equipment has been used at one mine site and undoubtedly has potential for revegetation of these sites.

Although it was built for seeding overgrazed grass and shrub ranges, we have found it also works well on cleared forest or mined sites.

Automatic Transplanter Design Progress

H. L. Brewer, *Science and Education Administration*

Abstract—I previously reported work on a packaging system to facilitate mechanization of growing and planting grass seedlings.[1] This system was extended to accommodate tree seedlings as well.[2] Having demonstrated the feasibility of using bandoleered containers as a way of growing seedlings economically, I turned my attention to the design of an automatic transplanter to speedily plant individual plugs.

After trying various dibbles, we found that the Moden dibble,[3] scaled to half-size, worked quite well for our small plugs of 8-mm diameter by 60-mm long. Because of their small size, these plugs, when bare, have a tendency to stick in the dibble; so, some consideration is being given to leaving the plugs in their polyethylene casing, with one side split so that roots will not be bound.

Work is progressing on the automatic feed of the bandoleer to the planter. This has two main components: (1) a uniform feed of plugs to the dibbles, and (2) a faster cycling subsystem that clips plugs from the bandoleer, culls out plugs with no plants, and a register to feed the uniform feeder.

No work is being done at present on automating the fabrication or filling and seeding of the bandoleers, although at least one private company thinks that this shouldn't be too difficult to do.

Water Harvesting Research Implementation

Gary W. Frasier and Keith R. Cooley, *Science and Education Administration*

Water harvesting as a means of water supply is an old concept dating back over 4,500 years. Some of these early systems were used to supply water for the supplemental irrigation of crops. Others, in the form of roof-top collectors, are still being used to supply domestic household water.

The first water harvesting catchments constructed in modern times for animal drinking water usually had aprons of concrete or sheet metal. These units were relatively expensive, but were, in general, a successful means of water supply.

In the early 1950's, butyl rubber sheeting became available for catchment aprons and, based on laboratory tests, were projected to have an effective life of over 25 years. The relatively long life expectancy plus the "simple" installation of the rubber membranes were major factors in the widespread acceptance of the material for water harvesting. Some of these butyl rubber catchments have been successful.

On many of the units, problems were encountered after about 5 years, with the sheeting being damaged by rodents, wildlife, cattle, birds, and wind. Often, problems were compounded by an increased rate of deterioration of the sheeting caused by improper installation techniques, which placed the rubber under stress. Many of the failures could be attributed to the lack of preventative maintenance. Because of the failures of these catchments, many users became disenchanted with water harvesting as a means of water supply.

In 1960, the U.S. Water Conservation Laboratory of the Science and Education Administration at Phoenix, Ariz., initiated a research program to develop better methods and lower cost materials for water harvesting systems. A water harvesting system is defined as the collection apron, the water storage facility, evaporation control of the stored water, and peripheral items such as fencing and drinking troughs. The main areas of investigation in these studies were:

- Materials for use as catchment aprons.
- Reducing evaporation loss from stored water.
- Optimum design of the relative sizes of the catchment apron and the water storage facility.
- Methods and materials for water storage.

In 1978, part of the water harvesting research investigations was transferred to the Science and Education Administration Southwest Rangeland Watershed Research Center at Tucson, Ariz. Studies were initiated in the use of water harvesting techniques as (1) a tool for range management in providing dispersed water facilities to better distribute livestock and wildlife on the range and to allow for better use of pasture rotation during periods when other water

[1] Brewer, H. L. 1978. Automatic transplanter system for field crops. ASAE Paper No. 78-1011 (mimeo.), 19 p.

[2] Brewer, H. L. 1978. Bandoleered containers for automatic transplanter systems. Abstract to be published in Proceedings of SA Forest Tree Nurserymen's Conference, Hot Springs, Ark., July 24-27, 1978.

[3] Moden, W. L., Jr., T. W. Chappell, and F. H. Pitkin. 1976. An intermittent dibble-type container planter. ASAE Paper No. 76-1570 (mimeo.), 26 p.

supplies are not adequate, and (2) the use of water harvesting-runoff farming techniques as a means of increasing forage production and for the establishment of desirable range plants.

Much of the emphasis of the early studies was on the development of new materials that could be used for the catchment apron. Of the many materials evaluated, two treatments have proven effective for waterproofing the catchment. These treatments are the asphalt-fiberglass membrane and the paraffin wax soil treatment.

The asphalt-fiberglass membrane is installed by laying a matting of chopped fiberglass on the prepared catchment surface. The matting is treated with two coats of a roofing-grade asphalt emulsion. The first coating penetrates through the fiberglass matting and helps bond the membrane to the soil surface. The second coating provides the final waterproofing sealcoat to the surface. These membranes have been evaluated under operational field conditions for over 10 years. They have been installed in a wide range of climatic conditions, from the lower desert areas of Arizona to the high mountains of Colorado.

The paraffin wax soil treatment consists of melting and spraying a low-melting point refined paraffin on the prepared catchment surface. The molten wax solidifies upon contact with the soil, but the sun's heat remelts the wax, allowing it to soak into the soil to a depth of about ¼ to ½ inch. The wax does not plug the soil pores, but instead coats each invidual soil particle, forming an effective water repellent layer of soil that prevents the water from infiltrating. The wax treatment is still being evaluated to determine under what soil and climate conditions it will be suitable.

Two methods of evaporation control for use on water harvesting systems have been evaluated. One method, which may be suitable for the hotter desert areas, consists of applying molten paraffin to the water surface. Sufficient wax is placed on the water to form a layer about 1/8 to ¼ inch thick. This layer will crack in the winter, but as the sun warms the water surface, the wax partially remelts and forms a continuous cover. The second method of evaporation control consists of using a floating cover of foamed synthetic rubber. These covers have been used in a wide range of climatic conditions very successfully on tanks up to 30 feet in diameter.

Operational water harvesting system in the Arizona Strip furnishes water needs for several hundred head of livestock.

A simple computer program was developed to determine the optimum size of the catchment and storage required based on unit costs using an estimate of the precipitation and animal water requirements by months. This program is being used to assist water harvesting users to properly design water harvesting systems to fit the precipitation patterns and water requirements of the local area. Suitable water storage methods are currently the most expensive item of a water harvesting system. Limited studies have been conducted with improved methods and materials that can be used for the water storage, but we are still lacking a completely suitable means.

Today, water harvesting systems are being installed in increasing numbers as a means of water supply for wildlife and livestock. Some units are an acre in size with over 80,000 gallons of storage and are capable of furnishing all the water requirements for several hundred head of livestock.

The costs of the systems are highly variable, depending upon the types of material used and the local site conditions. Typical wildlife units (5,000 square feet catchment, 15,000 gallons of storage) are costing \$5,000 to \$10,000, while large livestock watering systems (50,000 square feet catchment, 80,000 gallons of storage) are costing over \$20,000.

Even with the relatively high cost, the water provided by these systems costs less than when obtained by other means, such as pipelines or hauling. In many areas, a water harvesting system is providing the water that is facilitating effective utilization of the forage produced on the land.

Studies of using water harvesting-runoff farming techniques for establishing or increasing forage production are still in the small plot stage. Many techniques have to be developed before field application can become a reality.

Grazing Reserve Development in Alberta

W. N. McLachlan, *Alberta Department of Energy and Natural Resources*

The Province of Alberta through the Department of Energy and Natural Resources Lands Division has or is in the process of developing some 28 grazing reserves. A grazing reserve is a totally Government-owned-and-operated pasture where all development, such as clearing, breaking, seeding, fencing, etc., is paid for by the Province. A fee is then charged to those who are accepted as patrons on the basis of each a.u.m. (animal unit month) that is allocated to them.

In the northwestern and central parts of the Province, the principal means of developing new pasture is by clearing the land of deciduous cover, mainly poplar (*Populus tremuloides*), and willow (*Salix spp.*). The coniferous species are not cleared nor are areas with good regeneration potential for coniferous species.

In 1976, the Provincial Government allocated some \$26 million to new reserve development over a 10-year period. The program allows for the development of some 10 to 15 new reserves. For each site approved for development, an interdepartmental planning team reviews the site and makes recommendations as to the final development configuration. The planning team is composed of designated representatives from Public Lands Division, Alberta Energy and Natural Resources; Alberta Forest Service, Alberta Energy and Natural Resources; Fish and Wildlife Division, Alberta Recreation, Parks and Wildlife; Economics Services Division, Alberta Agriculture; Land Conservation and Reclamation Division, Alberta Environment.

The team is chaired by the Resource Planning Branch of Alberta Energy and Natural Resources, which coordinates the planning process. In general terms, only 50 percent to 60 percent of the total acreage for a given reserve is cleared and seeded. The reserves will vary in size from 6,000 acres to about 40,000 acres, the average being about 17,000 acres.

The development procedure is as follows:

The area selected for developing is cleared using bulldozers, either by cutting the trees with a V-cutter or by walking the trees down with the dozer raised about 3 feet off the ground. Either method is satisfactory. The choice depends on the size of the tree being cleared and individual preference of the project supervisor. The walking down method tends to remove more of the root system but does allow the collection of soil into the windrow. The fallen trees are pushed into windrows for burning and therefore the windrow must be well compacted. For the cutting and piling process, the use of D-8 Caterpillar equipment or equivalent is considered the optimum.

The brush is cleared during the winter months when the ground is usually frozen.

The following summer, the area cleared is broken and the windrows are burned. The debris remaining after the burning is repiled into circular piles. The breaking is done either by moldboard plow or with a Rome Tandem disk. The disk must have at least 30-inch cutters and weigh in excess of 500 pounds per blade. The Rome or equivalent is preferred for disking. Four-

bottom land breakers (moldboard plow) that will cut an 8-foot swath have been developed by private industry. Each bottom cuts a 24-inch furrow, and the plow is usually pulled with a D-8H or equivalent power unit. The plow may either be a two, three, or four bottom in size.

We then leave the area until the following summer before working down and seeding. We found that by leaving the area one season we cut down on our regrowth problems. When the area was broken with a disk, we work that down by using a disk of similar size. When the area is plowed with a moldboard, we use a tandem disk with a 22-inch spacing and disk the area twice. The first pass should be at a 45° angle to the furrow. The seed is applied in conjunction with the final disking, either an attached dribble-type seeder or a trailing seeder. The method of covering the seed is via a chain-type of drag. Old heavy-duty truck chains work the best.

The seed mixture in the brushland areas is a mixture of: 40 percent brome, 30 percent fescue, 20 percent alsike clover, and 10 percent timothy. The percentages will sometimes vary. We have also used meadow foxtail, but it is difficult to seed. On one project, which is an old lake bottom, reed canary was used. In southern Alberta, under dryland conditions, we use Russian wildrye or crested wheatgrass with alfalfa.

During the course of the next 4 to 5 years, we expect to be clearing 20,000 to 25,000 acres of brushland—breaking the same and seeding about the same amount each year.

After the area is seeded, cattle are introduced, usually the second year after seeding. We consider it takes about 3 years for a grass legume stand to become fully established. We are faced, of course, with substantial regrowth problems and are using chemical means to control, but we are currently embarking on a fairly comprehensive controlled burning program.

Some relative costs:

- Clearing @ $50 to $60 per acre: $55.
- Burning, repiling, and breaking @ $25 to $40 per acre: $35.
- Working down and seeding @ $25 per acre: $25.
- Seed @ $7: $7.

Some other associated development costs:

- Fencing, including labor and materials, @ $1,800 per mile.
- Dugouts (4,000 cubic yards) @ $2,700 each.

The cleared and seeded areas will, in general terms, support 1 a.u.m. per acre. This will vary from 1.4 to 0.6 a.u.m.'s per acre depending on rainfall in the area. The resulting capacity represents a fivefold increase over the native state. Under present market conditions and prices, the development is viable. The viability of land development will vary, of course, in accordance with the livestock market at the point when the work is being done.

Equipment Development & Test Funding

Planning and Budgeting Procedure

For many years the "Range Reseeding Committee" was an informal group, meeting each year to exchange information on work of mutual interst and to develop project proposals for work to be done by Equipment Development Centers or field units. The proposals were written, estimated for cost, and finalized "on the spot." Informal but it seemed to work!

Today there are demands being placed on us to plan in detail 2 years in advance, and in general 5 to 10 years ahead. This does take away some of the informality of the operation and dictates the need for a more organized approach to the preparation and submittal of project proposals. Figure 1 shows a plan by which we can meet our budgeting dates. It provides a mechanism whereby the Equipment Development Centers can stay with the budget process of the Forest Service.

The other aspect of our planning procedure is a more uniform format for project proposals. Figure 2 is a suggested guideline for proposals. Following this guide will help all concerned in preparing and reviewing proposals. It should make the flow of information more efficient and provide a much better story for those who must analyze needs, prepare programs, and assign priorities.

We hope that everyone associated with the Vegetative Rehabilitation and Equipment Workshop will cooperate in this more formal approach. It should be an aid to everyone. If any questions arise or there is a need for help in this process, call the Centers or the Washington Office.

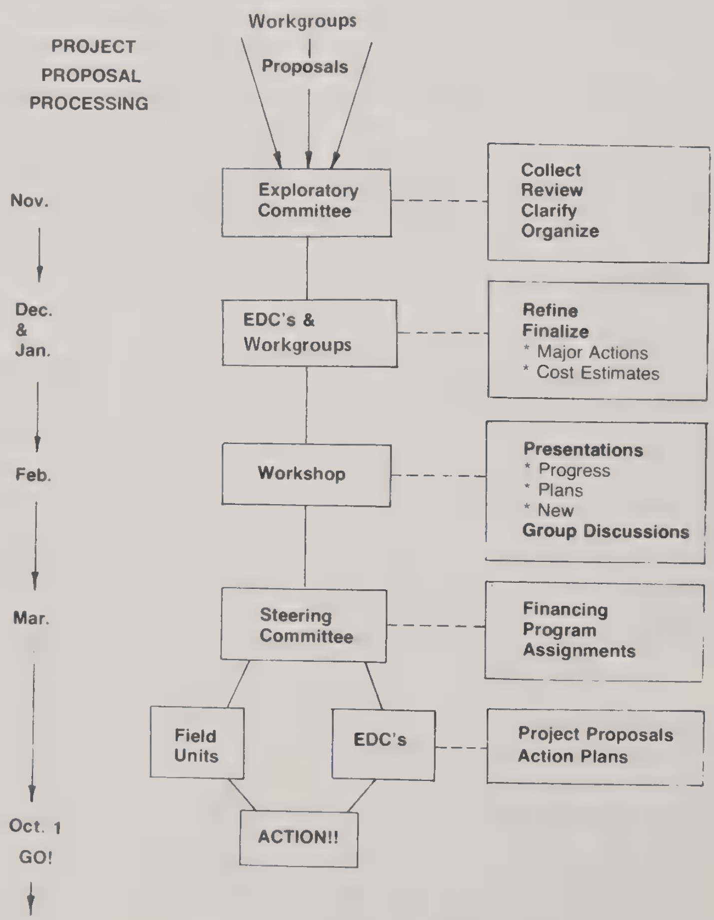


Figure 1. – Project proposal processing.

(PROJECT PROPOSAL FORMAT)

EQUIPMENT DEVELOPMENT AND TEST PROJECT PROPOSAL FOR FY ____

ED&T Project No. (Leave Blank)
Date ______________
Primary Interest: ________

____
(TITLE)

- *(The title should be brief and indicative of project objectives.)*

PROBLEM STATEMENT AND OVERALL OBJECTIVES

- *(State the problem and describe how the work is currently being done. Tell what equipment, materials, or methods are used, and why change or improvement is needed. Show significant advantages and potential savings, such as: increased production or efficiency, property or human hazard reduction, reduced maintenance, and public demand or reaction.)*

- *(State the overall objectives. What is to be accomplished or what is to be achieved by this project?)*

- *(Include amendments to the problem statement and overall objectives, if necessary (for completion by the Development Centers for applicable continuing projects only). The statements of the original problem and objectives should not be changed. If there is a change in emphasis, add revised problem statements and objectives here.)*

SPECIFIC REQUIREMENTS

- *(Distinguish between minimum requirements and those which are desired but not essential. Describe features required or specify performance characteristics. Where more information will be needed but cannot be furnished, list items that should be explored.)*

PRIOR DEVELOPMENT

- *(Briefly describe work already completed or underway which is related to this project. On new projects, this work will generally have been done by other persons or organizations or under other equipment development projects. For a continuing project, tell when it started and briefly state major accomplishments, and actions planned for completion in the current fiscal year. Reference the overall project time frame and total cost estimate if previously made and if applicable, prior reports and publications.)*

PROJECT ORIGIN

- *(Show the name, organization, etc. of persons originating the project and preparing the project proposal.)*

Figure 2. – Format for project proposal.

FY 1979 PROGRAM

Missoula

Project No.	VREW	Amount
1450	Technical Services, Range	$ 16,000
7083	Information Workgroup Support	9,000
8022	Range Equipment Handbook	11,100
		$ 36,100

	BLM-EMRIA[1]	
1454	Technical Services, BLM	$ 37,000
8041	Basin Blade	37,800
8042	Dry Land Plug Planter	80,000
8046	Dry Land Sodder	66,000
9120	Sprigger for Native Shrubs	29,700
		$250,500
		$286,600

San Dimas

	VREW	
1421	Technical Services, Range	$ 16,000
2532	Interseeder for Rocky and Brushy Areas	10,000
2623	Lightweight Seed Collectors	24,900
		$ 50,900

Source	MEDC	SDEDC	Total
FS-RGE	$ 25,100	$ 30,900	$ 56,000
BLM-Regular	11,000	10,000	21,000
BLM-EMRIA	250,500	—	250,500
BIA	—	5,000	5,000
F&WLS	—	5,000	5,000
	$286,600	$ 50,900	$337,500

[1] Funded by BLM-EMRIA.

Range Publications and Drawings

Below are titles of reports on a variety of range rehabilitation topics, as well as a list of range equipment fabrication drawings. These materials have been produced by the Forest Service Equipment Development Centers at Missoula (MEDC) and San Dimas (SDEDC) and may be of interest to workshop members. Single copies of the reports and drawings are available without charge by writing to the appropriate Center:

Forest Service, USDA
Equipment Development Center
Bldg. 1, Fort Missoula
Missoula, Mont. 59801

Forest Service, USDA
Equipment Development Center
444 East Bonita Ave.
San Dimas, Calif. 91773

The list of publications includes *Equip Tips*, concise reports dealing with new equipment, new uses for equipment, and similar topics; *Equipment Development & Test (ED&T) Reports*, documenting major development studies; *Project Records*, describing the technical details of development work, including procedures, results, conclusions, and recommendations; a number of special reports, ASAE papers, and service manuals are listed under "Other Reports."

Equip Tips

Steep-Slope Seeder for Roadside Slope Revegetation, Feb. 1979 — SDEDC

Improved Method for Joining Plastic Pipe, Dec. 1978 — MEDC

Seed Dribblers (revision no. 1), July 1977 — SDEDC

Spray Boom Assembly, July 1972 — SDEDC

Plastic Pipe Laying Machinery, Jan. 1966 — SDEDC

Browse Seeder with 20-inch Scalpers, Jan. 1965 — SDEDC

ED&T Reports

Catalytic Converter Exhaust System Temperature Tests, Feb. 1977 — SDEDC

Slash...Equipment and Methods for Treatment and Utilization, April 1975 — SDEDC

Clearing, Grubbing, and Disposing of Road Construction Slash, Oct. 1976 — SDEDC

Roadside Slope Revegetation, June 1974 — SDEDC

Flexible Downdrains, Jan. 1974 — SDEDC

Tractor Attachments for Brush, Slash, and Root Removal, Jan. 1971 — SDEDC

Results of Field Trials of the Tree Eater, Jan. 1970 — SDEDC

Forestland Tree Planter, Sept. 1967 — SDEDC

Pine Seed Drill, Sept. 1967 — SDEDC

Project Records

Mulching-Tilling Equipment for Soil Conditioning, Jan. 1979 — MEDC

Evaluating Methods for Joining Polyethylene Pipe, Dec. 1978 — MEDC

A Transplant System for Revegetating Surface Mined Lands, Nov. 1978 — MEDC

Field Equipment for Precommerical Thinning and Slash Treatment, July 1978 — SDEDC

Interseeder for Rocky and Brushy Terrain (progress report), Jan. 1978 — SDEDC

Modified Hodder Gouger, Dec. 1977 — MEDC

An Investigation of Equipment for Rejuvenating Browse, Aug. 1977 — MEDC

Survey of High-Production Grass Seed Collectors, Jan. 1977 — SDEDC

Remote Sensing for Big Game Counts, Dec. 1976 — MEDC

Evaluation of the Vermeer Model TS-44A Tree Spade for Transplanting Trees on Surfaced Mined Land, Feb. 1976 — MEDC

Wildlife Habitat Management Needs, Oct. 1975 — MEDC

Using Heat for Sagebrush Control, Feb. 1972 — MEDC

Other Reports

Front-End Loader Tree Spade — Manual Supplement, Feb. 1979 — MEDC

32nd Annual Report — Vegetative Rehabilitation and Equipment Workshop, Aug. 1978 — MEDC

Concepts — Sod Mover, Aug. 1978 — MEDC

Aerial Burning Equipment for Fiant Control, Feb. 1977 — MEDC

Handbook — Equipment for Reclaiming Strip Mined Land, Feb. 1977 — MEDC

Rangeland Drill Operations Handbook, BLM Tech. Note 289, Sept. 1976 — SDEDC

Evaluation of Power Requirements and Blade Design for Slash Cutting Machinery (ASAE paper), Dec. 1974 — SDEDC

Evaluation of the "Vari-Dozer," Feb. 1974 — SDEDC

Investigation of Selected Problems in Range Habitat Improvement, Feb. 1974 — SDEDC

History — Range Seeding Equipment Committee 1946-1973, Jan. 1974 — MEDC

Results: 1972 Range Improvement Survey (27th annual Range Seeding Equipment Committee report), Feb. 1973 — MEDC

Implement-Carrying Hitch for Forestry Use (ASAE paper), Dec. 1972 — SDEDC

Efficiency and Economy of an Air Curtain Destructor Used for Slash Disposal in the Northwest (ASAE paper), Dec. 1972 — SDEDC

Service & Parts Manual for the Contour Furrower Model RM 25, June 1970 — SDEDC

Service & Parts Manual for the Brushland Plow, June 1968 — SDEDC

Service & Parts Manual for the Rangeland Drill Models PD-10x6 and B-20x6, Aug. 1967 — SDEDC

Drawings at SDEDC

Pipe Harrow, RM1-01 and 02

Brushland Plow, RM2-01 to 22

Electric Broadcast Seeder, RM5-01 to 02

Beach Grass Planter Assembly, RM13-01 to 05

Spray Rig Assembly (D-7), RM15-01 to 04

Spray Rig Assembly, RM16-01 to 06

Oregon Press Seeder Assembly (not complete), RM19-01 to 07

Spray Rig 160-Gallon, Side-Mounted Tanks, RM20-01 to 05

Plastic Pipe Layer Assembly, RM21-01 to 03

Reel for Laying Plastic Pipe, RM24-01

Contour Furrower, RM25-01 to 14

Rangeland Drill, RM27-01 to 45 (obsolete)

Rangeland Drill Deep Furrowing Arms, RM27-46 to 61

Steep-Slope Seeder, RM33-01 to 18

Drawings at MEDC

Dryland Sodder, no. 631

Tubeling Planter, no. 628

Basin Blade, no. 619

Horse Trap Trigger, no. 618

Mulch Spreader, no. 611

Tree Transport Container, no. 604

Tree Transplant Trailer, no. 602

Modified Hodder Gouger, no. 583

Dixie Sager and Modified Ely Chain, no. 568

Incendiary Grenade Dispenser, no. 522

Attendance at Annual Meetings

Meeting		Participants				
Date	*Place*	*Federal Gov't*	*State Gov't*	*Private*	*Foreign*	**Total**
Dec 1946	Portland	6	0	0	0	6
Dec 1947	Ogden	9	0	0	0	9
Jan 1949	Denver	15	0	0	0	15
Dec 1949	Ogden	22	0	0	0	22
Jan 1951	Billings	34	5	0	0	39
Jan 1952	Boise	45	9	0	0	54
Jan 1953	Albuquerque	75	15	9	1	100
Jan 1954	Omaha	63	8	3	5	79
Jan 1955	San Jose	62	10	4	1	77
Jan 1956	Denver	86	12	1	2	101
Jan 1957	Great Falls	95	10	4	0	109
Jan 1958	Phoenix	87	9	3	0	99
Jan 1959	Tulsa	84	5	2	0	91
Jan 1960	Portland	98	10	3	3	114
Jan 1961	Salt Lake City	123	11	14	2	150
Jan 1962	Corpus Christi	58	5	7	1	71
Jan 1963	Rapid City	52	6	1	0	59
Jan 1964	Wichita	61	10	5	0	76
Jan 1965	Las Vegas	77	8	6	0	91
Feb 1966	New Orleans	47	8	5	1	61
Feb 1967	Seattle	58	10	4	0	72
Feb 1968	Albuquerque	84	16	13	1	114
Feb 1969	Great Falls	46	3	12	0	61
Feb 1970	Denver	81	8	11	0	100
Feb 1971	Reno	74	6	15	2	97
Feb 1972	Wash., D.C.	48	3	6	0	57
Feb 1973	Boise	60	7	7	4	78
Feb 1974	Tucson	61	12	10	14	97
Feb 1975	El Paso	49	9	11	1	70
Feb 1976	Omaha	50	17	12	0	79
Feb 1977	Portland	63	26	31	10	130
Feb 1978	San Antonio	68	26	35	6	135
Feb 1979	Casper	74	35	72	12	193

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Note from VREW Chairman Ted Russell

Persons interested in participating in the activities of a workgroup are encouraged to write or call the workgroup chairman about their interest.

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